Education in Geoinformatics - Career Profiles, Requirements, and Chances

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Abstract

The Institute for Geoinformatics (ifgi), University of Münster plans to introduce new Bachelor and Master Programs in Geoinformatics (GI). The re-design of the current programs' content takes into account the educational requirements of GI companies and organizations where our Bachelors and Masters will start their professional life. The best way to know about the requirements is to ask the GI professionals themselves. We developed an online questionnaire which has been addressed to over 1000 GI professionals in Germany. Results are (i.) Profiles of companies and organizations engaging GI professionals, with career profiles and tasks of GI professionals, (ii.) Knowledge and competences of GI Bachelor and Master Graduates required by different types of careers in private, public sector, and education, and (iii.) Career chance assessments of Bachelor and Master Graduates in Geoinformatics. Based on the evaluation of the results, we will provide recommendations for (re-)design of new GI Bachelor and Master Programs.

Introduction

The Institute for Geoinformatics (ifgi), University of Münster offers the first Diploma Program in Geoinformatics in Germany. Due to the Bologna process, the diploma program will be transferred to new Bachelor and Master Programs. Our goal is to investigate the requirements of the GI market towards the future GI Bachelor and Master Graduates. Based on these requirements, we will improve the GI curricula according to these needs. Thus, we target enhanced chances of our students for their future careers as GI professionals in private, public sector, and education.

The following section will describe an online-questionnaire and its evaluation as a method to identify the requirements of the GI market. Afterwards, we will describe the achieved results in terms of

- profiles of companies and organizations working in the GI field,
- career profiles of GI professionals,
- requirements towards GI education, and
- career chances of specific GI Bachelors and Masters .

Finally, we will discuss the results and provide an outlook on further work.

Method – Online-questionnaire for GI professionals

Our key method is to use an online questionnaire, which focuses on three groups of questions:

- Profiles of the addressed GI professionals and their working environment
  - Sector of company/organization (private, public sector, education, others), size of company/organization, and involvement in GI
  - Educational background and tasks of test persons within their company/organization
- Required knowledge and competence the GI Bachelor and Master Graduates expected from their future employees
  - Know-how and competence in GI, Geosciences, Informatics/Mathematics, others
  - Additional key competences, e.g., project management, languages
- Assessment of respondents about the career chances of GI Bachelor and Master Graduates of three specific programs
  - GI Bachelor
  - GI Master, based on a GI Bachelor
  - Master in Geospatial Technologies, based on any Bachelor.

We started our survey with a test phase with 18 ifgi staff members. They filled in the questionnaires in analogue form, under observation of the author. Based on their answers and hints, the questionnaire was improved by form and content to its final version. Afterwards, we addressed over 1000 GI professionals in Germany by email and asked for filling in the online questionnaire (http://ifgi.uni-muenster.de/templ-js.php?l=de&i=1_aktuelles/sonstiges/berufsperspektiven_umfrage/fragebogen). Data was collected from May 9-22, 2004.

For the data treatment, we converted the information from Access to Excel and imported to SPSS 8.0. We validated the data by eliminating double entries. We received a feedback of 218 valid entries of GI professionals. For this particular method of polls using questionnaires, the feedback rate of ~ 20 % can be considered as successful. In addition, we are satisfied with the total number of 218, because it provides a large enough data base for significant results, and there is a sufficient number of GI professionals from private sector, education, and public sector.

The following three sections describe and discuss the results according to the three sections of the questionnaire: Profiles of subjects and their companies or organizations, required knowledge and experiences towards GI Bachelor and Master Graduates looking for their first job, and the career chances of graduates of three specific GI Bachelor and Master programs.

Results – Profile of test persons and their organizations

This section will first describe the profiles of the companies and organization the addressed GI professionals are working in. Then we will describe their career profiles in terms of position, working fields, and educational background.

Profiles of companies and organizations

This first section of the survey aims to the understanding of which company or organization the subjects are working. 44% of the companies or organizations are mostly engaged in Geoinformatics, 32 % partly, and 23% of them are marginally engaged:

Table 1: Engagement of companies/organizations in Geoinformatics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mostly	96	44,0	44,4	44,4
	Partly	70	32,1	32,4	76,9
	Little	50	22,9	23,1	100,0
	Total	216	99,1	100,0	
Missing	System	2	,9		
Total		218	100,0		

The following table evaluates the companies and organizations of the subjects by their sectors and sizes.

Table 2: Sectors and sizes of companies and organizations

	Sectors					
Number of employees	Private sector	Education	Public sector	Others	No answer	Total
< 10	15	6	2	1	7	31
10 - 50	19	14	13	3	12	61
> 50	22	27	39	14	24	126
Total	56	47	54	18	43	218

The evaluation shows a rather even distribution amongst private, public sector, and education (47 – 56 entries, ~ 25 % each sector). More the 50 % of the respondents are working in big companies organizations with more the 50 employees, especially in the public sector. The “no answer” entries seem to result by a weakness of the questionnaire, not stating clearly enough the need to classify the test person’s company/institution into one of the sectors. This has two effects on the results:

- Some respondents did not state the sectors of their companies and institutions, but however provided relevant information on the working fields within these sectors. In order not to miss

this information, the sector-specific working fields showed in figures 1, 2, and 3 do not refer to the number of subjects working in this sector, but to a total number of 218 test persons. This affects low percentages, but still the evaluation shows the relative percentages of the working fields.

- The sector-specific requirements towards young GI professionals (see table 4) rely on 157 test persons instead of ~ 200 test persons. Although loosing some valid entries, we still think the number of ~ 50 test persons per sector sufficient for relevant information.

The survey covers a wide range of different companies and organizations, although the focus is on those mostly engaged in the GI sector and with more than 50 employees. The following evaluations provide a closer look on the working fields within the three sectors.

In the private sector, most of the companies work in the field of GI/GIS application (30,3 %) and GI/GIS development (22,0 %) (see figure 1). Further significant working fields are GI consulting, Traffic/transport (17,9 %), and Energy providers (14,7 %). Other working fields are covered with less than 12 %.

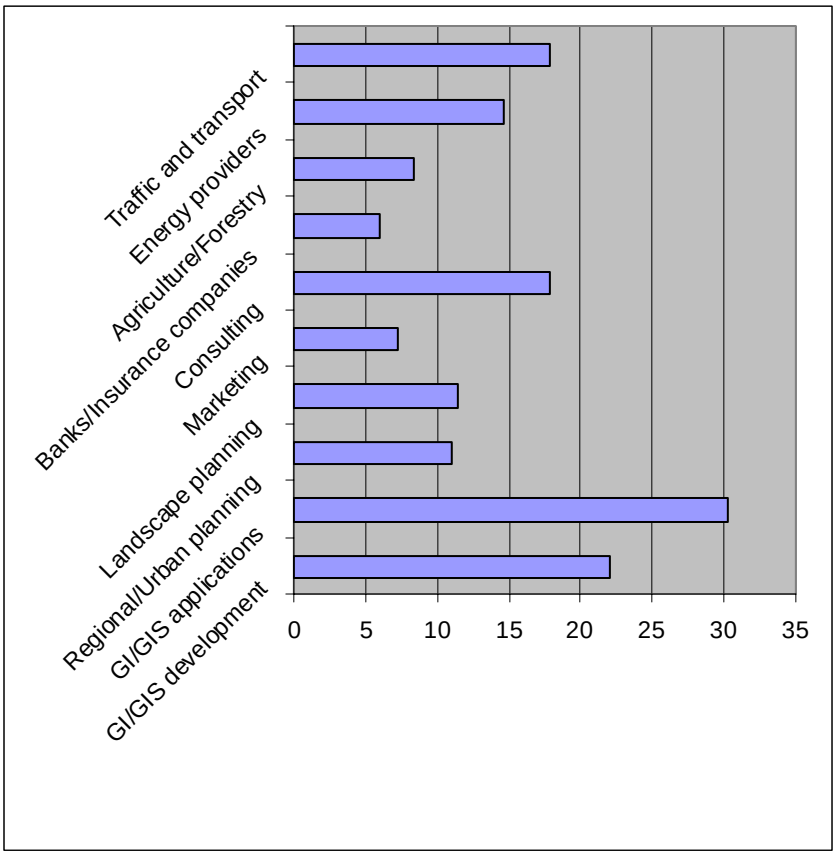

Figure 1: Working fields in the private sector (in % referring to 218 test persons)

Within the sector of education, most of the respondents are working in universities (20,2 %, see figure 2). 6,0 % of the respondents are working in universities for applied sciences, 2,8 % in other scientific organizations.

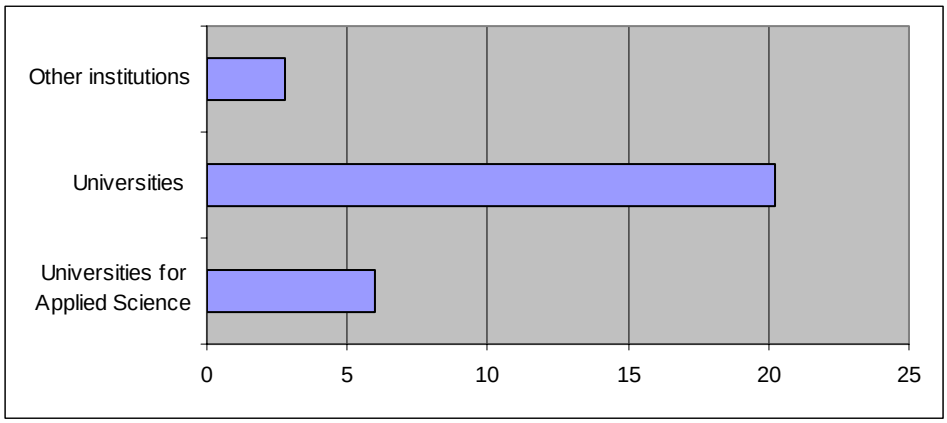

Figure 2: Institutions in Education (in % referring to 218 test persons)

In the public sector, there is high evidence in working in GI applications (29,8 %, see figure 3). We also observe a high number of test persons' organizations working in surveying (20,2 %), administration (18,8 %), and landscape planning (17,9 %). Further working fields are regional, traffic, and other planning tasks (13,8 – 14,7 %).

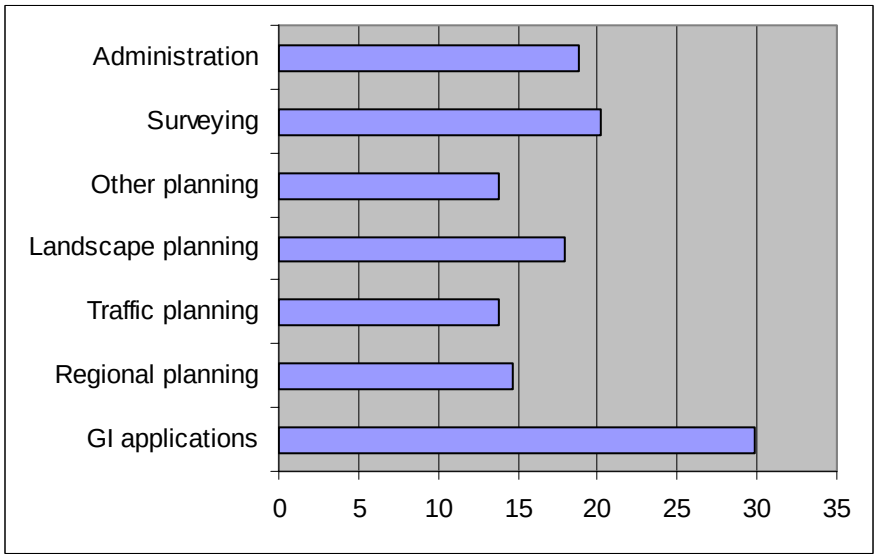

Figure 3: Working fields in the public sector (in % referring to 218 test persons)

Profiles of respondents

After analysing the GI professionals' companies and organizations, we will now describe their career profiles in terms of position, working areas, and educational background.

The distribution of positions is balanced (see table 3). 38 % of the subjects are employees, 26 % are involved in junior management, 34 % in senior management. Thus, the survey relies on a broad cross-section through the GI market.

Table 3: Position of employee

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		4	1,8	1,8	1,8
	employee	84	38,5	38,5	40,4
	junior management	57	26,1	26,1	66,5
	senior management	73	33,5	33,5	100,0
	Total	218	100,0	100,0	

The following figure shows the working fields of the respondents.

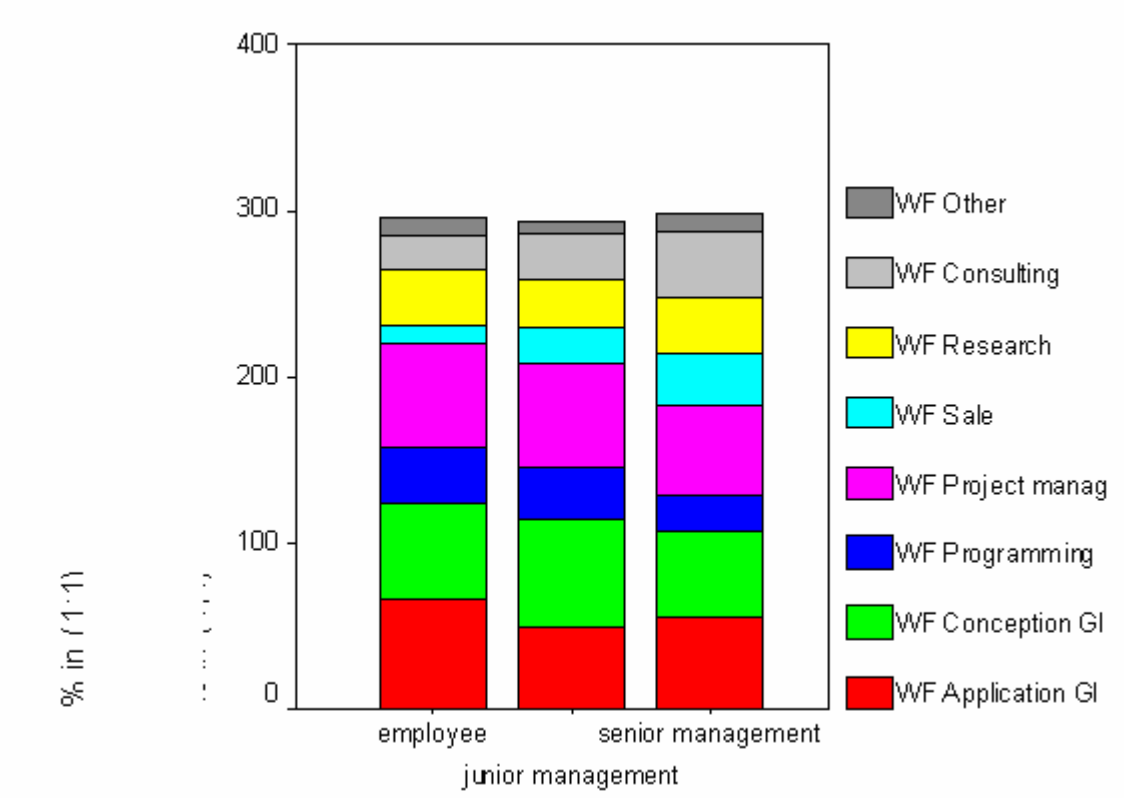

Figure 4: Positions and working fields (multiple entries possible, therefore numbers > 100 % occur)

The most interesting observation is similar working fields in lower and higher positions. There are expected shifts in the working areas, e.g., senior managers are more involved in consulting and sale than employees. However, shifts of working fields during the professional careers are small. The most important working fields are GI Conception and GI application. A third important working field is Project management. This is a significant result, showing that already in the beginning of the professional careers employees are deeply involved in project management.

The following figure describes the educational background of the test respondents.

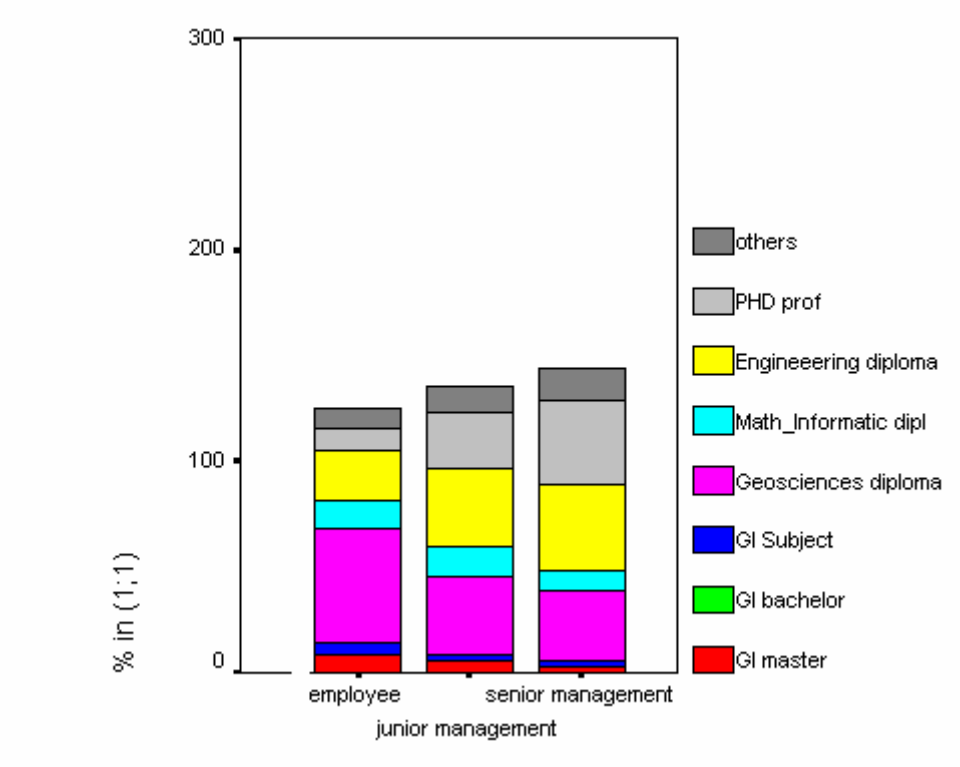

Fig. 5: Positions and educational backgrounds

As expected, academic titles (doctorate, professor) lead to higher positions in senior management. Since Geoinformatics is a young science, the number of 12 respondents with Master or Diploma degrees in Geoinformatics is still low. GI Bachelors were not amongst the subjects. Most respondents have either degrees in Engineering and Mathematics/Informatics, or Geosciences. An interesting observation is the high percentage of Geosciences diploma in lower positions, while in senior management we can find a higher percentage of Engineering degrees.

Results – Requirements towards GI Education

This section describes the required knowledge and additional key competences of GI graduates starting their professional careers. The second column of the following table shows the expectations of all respondents. The most required topics (assessed by > 60 % of all subjects) are marked in dark grey, topics required by 45-60 % are marked in medium grey, and 30-44 % is marked in light grey. In addition, the third, fourth, and fifth columns group the expectations of specific sectors (private sector, education, public sector). The results provide significant input for the curricula design of GI Bachelor and Master programs.

Table 4: Required knowledge and key competences

Required knowledge and key competences	**All respondents**	**Private sector**	**Education**	**Public sector**
Geoinformatics				
GI Systems and analyses	86,2%	80%	83,3%	91,4%
Spatial data bases	77,1%	78,5%	66,7%	84%
Cartography and Visualisation	63,3%	55,9%	63,3%	69,1%
Geostatistics	19,7%	17,2%	23,3%	19,8%
Numeric modelling	14,2%	12,9%	18,3%	9,9%
Remote sensing	24,2%	17,2%	25%	21%
Geosoftware development	46,3%	58,1%	55%	34,6%
Interoperability/Open GIS	42,7%	37,6%	55%	42%
Geodata infrastructures	52,8%	41,9%	63,3%	63%
Economic and legal aspects of GI	19,7	12,9%	18,3%	23,5%
Geosciences				

Required knowledge and key competences	**All respondents**	**Private sector**	**Education**	**Public sector**
Physical geography	14,7%	17,2%	15%	19,8%
Landscape ecology	14,2%	10,8%	11,7%	22,2%
Geology	12,4%	8,6%	13,3%	13,6%
Regional planning	28%	23,7%	16,7%	40,7%
Anthropogeography	5,5%	7,5%	6,7%	3,7%
Informatics/Mathematics				
Analysis	15,1%	11,8%	23,3%	8,6%
Discrete Mathematics	6%	4,3%	13,3%	3,7%
Numeric Mathematics	12,8%	8,6%	25%	6,2%
Programming languages	63,3%	65,6%	80%	54,3%
Information systems	59,2%	61,3%	63,3%	61,7%
Algorithms	29,4%	30,1%	46,7%	14,8%
Software engineering	45%	49,8%	60%	33,3%
Data modelling	66,1%	72%	75%	56,8%
New technologies/Multimedia	43,1	39,8%	45%	48,1%
Other specific know-how				
Economic sciences	7,8%	8,6%	6,7%	4,9%
Information systems	11%	16,1%	5%	4,9%
Marketing	17,9%	22,6%	10%	25,9%
Other	7,8%	7,5%	5%	6,2%
Additional key competences				
Practical experience	57,3%	66,70%	36,70%	64,20%
Project management	63,3%	68,80%	58,30%	69,10%
Rhetoric	23,9%	29%	15%	25,90%
Writing	37,6	33,30%	51,70%	28,40%
Presentation	56,9%	53,80%	66,70%	55,60%
International experience	11,9%	9,70%	20%	2,50%
Teamwork and cooperation	70,2%	65,60%	63,30%	76,50%
English	54,6%	50,50%	70%	43,20%
Other languages	2,3%	2,20%	3,30%	0%
Other key qualifications	4,6%	4,30%	6,70%	4,90%

As expected, knowledge in the GI topics is strongly requested. Primarily, the respondents assume knowledge in GI systems and analysis (86 %) and Spatial data bases (77 %). In the latter case, respondents from the education sector put a significantly lower emphasis (67 %) on Spatial data bases versus 78 % of those respondents from the public sector and 84 % from the private sector. Further important requirements are knowledge in Geodata infrastructures (53 % of all respondents), Geosoftware development (46 %), and Interoperability/Open GIS (43 %).

Know-how in Geosciences is considered of rather low importance. Physical geography, Landscape ecology, and Geology were required by ~ 15 % of all respondents. The biggest demand is in Regional planning (28 %). Within the public sector the demand for Regional planning even grows to 41 %.

The demand for knowledge in Informatics and Mathematics is high, although behind the demand for GI know-how. Mostly requested are Programming languages (63 % of all respondents), Data modelling (66 %), and Information systems (59 %). Further important topics are Software engineering (45 %) and New technologies/multimedia (43 %). An interesting observation is the higher demand for all of these topics by the respondents of the education sector compared with the demand of the private and public sectors.

Other specific know-how was required with a low priority. The biggest demand is for knowledge in Marketing (18 %). Again it is interesting to see that the demand within the private and public sectors is significantly higher (23 %, 26 %) than in education (10 %).

A key result of this survey is the high demand for additional key competences. Teamwork (70 %), Project management (63 %), and Practical experience (57 %) achieve the highest values. Again, the more demanded topics are higher valued in the private and public sectors than in education. For example, Practical experience is demanded by 64-67 % of the respondents from the private and public sectors versus 37 % in education. Also Rhetoric skills seem to be less appreciated in education (15 %) than in the private (29 %) and public sector (26 %).

Presentation skills (57 %), English language (55 %), and Writing skills (38 %) also achieve high percentages. In this case, these topics are higher valued by the respondents from the education sector versus those from the public and private sectors.

Results – Career Chances of Graduates of specific GI Bachelor and Master Programs

The third section of the online questionnaire asked for the estimated career chances of graduates of three new programs currently under construction. Each program was characterized by certain percentages of modules, e.g., Geoinformatics, Informatics/Mathematics, Geosciences, and key competences:

- GI Bachelor, 3 years with modules in Informatics/Mathematics (33 %), Geoinformatics (28 %), Geosciences (18 %), GI – practical experience (8 %), Additional key qualifications (4 %), and Bachelor thesis (9 %)
- GI Master (based on the GI Bachelor), 1,5 years, with modules in Informatics/Mathematics (22 %), Geoinformatics (24 %), Geosciences (14 %), Key qualifications (6 %), and Master thesis (34 %)
- Master in Geospatial Technologies, not basing on a previous GI Bachelor but on any Bachelor, 1,5 years, with modules in Informatics **or** Mathematics (10 %), New Technologies/Multimedia **or** Data modeling (10 %), Geoinformatics - basic courses (10 %), Geoinformatics - advanced courses (25 %), Geoinformatics - special courses (5 %), Additional key qualifications (10 %), and Master thesis (35 %).

The career chances of graduates were valued from 1 = very good to 5 = poor, see following figure:

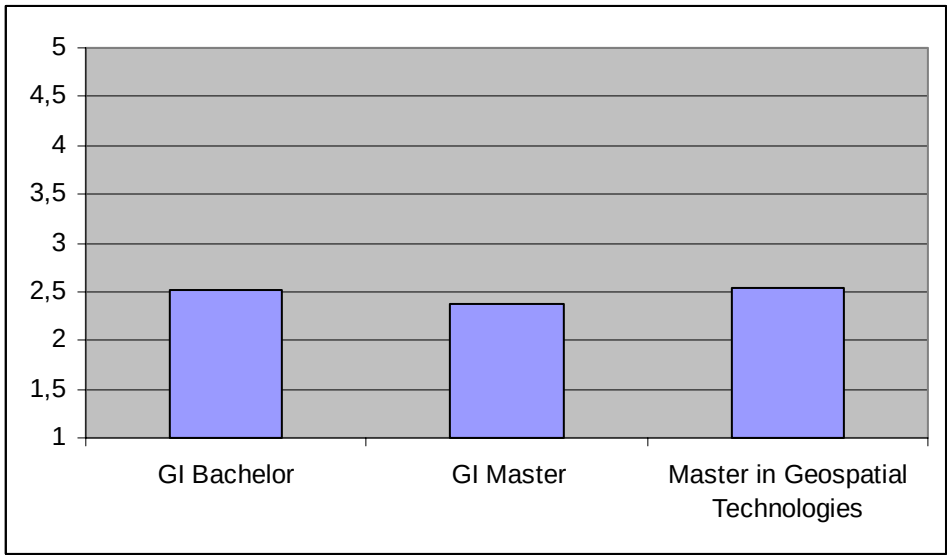

Figure 6: Career chances of GI Bachelor and Master Graduates

The career chances of graduates of the three programs are estimated in the range of 2 = good to 3 = satisfactory. In Germany, a key discussion point of the introduction of Bachelor and Master programs is their acceptance by employers versus the traditional Diploma degrees. Especially Bachelor programs are often considered as non-future oriented in terms of the graduates' career chances. This survey might give a hint to a fairly high acceptance of the new programs in the field of Geoinformatics.

The GI Master based on a GI Bachelor degree is mostly appreciated (2,38). Also the stand-alone Bachelor degree (2,52) is supposed to enable a good to sufficient career start, although the career chances are supposed to be a bit lower compared to the GI Master.

The Master in Geospatial Technologies achieves a similar value (2,53). A concern might have been that this program bases on *any* previous Bachelor program. Possibly, a focus of Bachelors of Informatics/Mathematics or Geosciences could improve the acceptance, because they already bring in some know-how and background into this Master program.

The following table differentiates the career chances according to the assessment of respondents from the private sector, education, and public sector (grading from 1 = very good to 5 = poor):

Table 7: Career chances of GI Bachelor and Master Graduates differentiated by sectors

Program	Private sector	Education	Public sector
GI Bachelor	2.6	2.4	2.7
GI Master (based on GI Bachelor)	2.5	2.1	2.6
Master in Geospatial Technologies (based on any Bachelor)	2.8	2.6	2.6

An overall observation is the higher acceptance of the new Bachelor and Master programs by respondents from the education sector, who are running the programs, versus the acceptance of respondents from the private and public sectors.

Conclusions and Outlook

The online-questionnaire was answered by 218 test persons. The big number and the balanced range of respondents from different sectors (private sector, education, public sector) and different positions (employees, junior and senior management) provide evidence for the results.

From the results, we conclude the following recommendations for the design of GI programs:

- The focus of the curriculum should address GI topics, i.e., GI systems and analysis, and Spatial data bases.
- Informatics/Mathematics are important modules of GI curricula, although to a significantly lower extend than GI topics.
- Geosciences should be addressed, although to a low extent.
- Additional key competences are a significant building block of a GI curriculum.
- The balance between the building blocks might vary according to the targeted professional careers of the GI program, e.g., a future career in authorities should involve know-how in regional planning.
- Decision makers designing a GI Bachelor or Master program mostly come from the education sector. Their estimation might significantly differ for from the demands of economy and authorities. For example, respondents from the education sector overestimated the relevance of the highest ranked topics of Informatics and Mathematics, while the need for know-how in Spatial data bases, Marketing, and additional key competences in Practical experiences and Project management were underestimated versus the demand from the private and public sectors. Therefore, university decision makers should take into account a potentially different demand of the future employers of GI graduates in the private and public sectors.

GI is becoming more and more an international business. German students might start their professional careers abroad; more and more foreign students are studying in Germany. Therefore, international requirements - instead of national ones - become more important for GI education. Consequently, we plan to extend this evaluation to European GI professionals. A second option is to extend the evaluation of professional GI careers to Latin-America, based on previous work in the ALFA project eduGI.LA (see www.eduGI.net/eduGI.LA/).