

On the Role of Professional Organizations in the Further Development Process of Study Programs

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SUMMARY

To support the further development process of geodetic study programs the multi-perspective Working Group 1 “Profession/Education“ of the professional organization German Association of Surveying (DVW) and the students’ organization Conference of Geodesy Students of German-speaking Universities (KonGeoS) are cooperating in the frame of the project DVWkon²GEOS. Within the continuously change process of study programs, DVWkon²GEOS is providing additional, independent, and standardized process perspectives, and therefore contributing to future-readiness of geodetic study programs. Hereby, the qualification aims and the design of the curriculum of geodetic study programs as well as the acquired competencies of graduates are analyzed with respect to the discipline-specific qualifications framework Geodesy and Geoinformation (FQR_GG), providing external and internal perspectives. FQR_GG was developed and ratified in 2018 by representatives of most relevant target groups (e.g., universities, professional organizations) and is based on the European and German Qualifications Frameworks and the Qualifications Framework for German Higher Education Degrees. The first study program to be analyzed was the German-speaking Bachelor study program “Geodesy and Geoinformatics” at the Karlsruhe Institute of Technology (KIT). Most important findings (e.g., heterogenic competency acquirement levels) and next project steps are presented.

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1. FURTHER DEVELOPMENT OF STUDY PROGRAMS

According to the Framework Act for Higher Education the duties of German universities are determined to maintenance science, basic research, and research-related education focusing on vocational preparation. This educational mandate is valid independent of the students' characteristics (e.g., increased heterogeneity) and social framework (e.g., increased globalization). Nowadays, massively and dynamically changing environment (e.g., OECD 2016) affects higher education significantly. In order to fulfill their educational mandate and to provide suitable and future-ready course offers, universities have to continuously adjust and further develop their study programs, guaranteeing a future-proof and sustainable framework for research, science, and labor market.

These change processes (Burke 2018) regarding the further development of study programs of the "specific organization" university (Musselin 2007, Kehm 2013) is mainly driven and supported by study programs themselves (e.g., curriculum), faculties (e.g., optimizing administrative processes), university administration (e.g., quality management based on evaluation of lectures), research findings (e.g., guidelines for teaching and learning), and government organizations (e.g., educational accreditation), meeting the dynamic and globalized demands of society, research community, and labor market. During change processes, external perspectives guarantee unbiased perceptions and the creation of new ideas. Therefore, within the German system of higher education, independent external perspectives are explicitly considered during the quality assurance process of educational accreditation each 5-7 years through external experts, especially. In this frame, study programs mandate experts to generate valuable feedback focusing on federal state dependent and university-specific quality measures as well as discipline-specific standards (Becher 1994). Within this state-wide process of educational accreditation, varying experts are encouraged to give feedback to different study programs based on their individual professional knowledge and experiences. One important feedback item of educational accreditation is dealing with the qualifications of graduates resp. the qualification aims of the study programs.

The paper is focusing on a very recent additional tool, which involves professional organizations in the process of the further development of study programs. In the project DVWkon2GEOS, the multi-perspective Working Group 1 "Profession/Education" of the German Association of Surveying (DVW) and the Conference of Geodesy Students of German-speaking Universities (KonGeoS; Brochhagen & Thiery 2019) are cooperating in order to establish an independent and more standardized qualification-related process perspective. Hereby, the qualification aims and the design of the curriculum of geodetic study programs are analyzed with respect to the discipline-specific qualifications framework Geodesy and Geoinformation (FQR_GG 2018).

Therefore, section 2 is focusing on the characteristics of FQR_GG, while section 3 describes the DVWkon²GEOS evaluation approach for the analysis of German study programs. The paper closes in section 4 with the presentation of (i) results of the first application of the DVWkon²GEOS framework on the German-speaking Bachelor study program “Geodesy and Geoinformatics” of the Karlsruhe Institute of Technology (KIT) and (ii) the next steps of DVWkon²GEOS.

2. DISCIPLINE-SPECIFIC QUALIFICATIONS FRAMEWORK FQR_GG

Within section 1, the focus was set on the reasons and motivations for the continuously further development of study programs of universities. In order to fulfill this important mission, one task is to regularly adjust current and to create new study programs with respect to future-readiness (e.g., modifications of curricula regarding new technologies and methodologies). In addition, based on topics, learning settings, and teaching approaches, the design of study programs enables graduates to acquire specific competencies individually; the quality of the outcome of this individual learning process has to be monitored as part of the quality management of universities.

The measurement of the “construct competency” (Shavelson 2010) resp. the level of outcome is not an easy task and therefore under research since the 1970s (e.g., Fitzpatrick & Morrison 1971, McClelland 1973). Nowadays, the additional competency-related focus is on individual lifetime success (Kautz et al. 2014) and transformation processes of societies (OECD 2018) for example.

The basis for this paper’s evaluation approach of German Geodesy study programs is the discipline-specific qualifications framework Geodesy and Geoinformation FQR_GG (2018). The FQR_GG was developed formally based on the European Qualifications Framework (EQF 2018), the German Qualifications Framework ([DQR](#)), and the Qualifications Framework for German Higher Education Degrees (HQR; German Rectors’ Conference 2005). Therefore, the FQR_GG is especially ...

- ... providing qualification profiles of graduates;
- ... using learning outcomes;
- ... describing competencies and skills of graduates;
- ... aiming at the promotion of student mobility;
- ... securing – for students and study programs as well as for employers, research, and the public – comparability, visibility of differences, and qualification aim transparency of study programs;
- ... guaranteeing study program’s quality on “Ingenieur” level;
- ... promoting life-long learning.

This enables the use of FQR_GG as a basis in evaluation, accreditation, and further development of study programs and curricula. Hereby, the FQR_GG distinguishes between professional, methodological, social, and self-competencies, where ...

- professional and methodological competencies are Geodesy-related;
- language competencies are required;
- reflective and innovative behavior are treated generically.

Table 1 presents details regarding competencies taken into account within FQR_GG.

Table 1: Compilation of competencies taken into account within FQR_GG; A: General basics, B: Discipline-specific basics, C: Discipline-specific knowledge.

	Professional competencies	Methodological competencies	Social competencies	Self-competencies
Number of competencies	1	6	3	5
Competency type	Discipline-related	Discipline-related	Personal	Personal
Specifics	Knowledge, understanding	Application and creation of knowledge	Communication, cooperation	Scientific self-conception, professionalism
Treated domains	<p>A: Mathematics, Physics, Informatics;</p> <p>B: Reference systems, geo-spatial reference, geo-data acquisition, geodetic measuring technique, data analyses, estimation theory, statistics, modelling and representation of geo-spatial information, legal framework;</p> <p>C: Earth observation, engineering Geodesy, Geo-informatics, photogrammetry and remote sensing, land and real estate management</p>	<p>Task-specific application of knowledge,</p> <p>research-related methodology,</p> <p>application and adaption of measurement and information technology,</p> <p>geo-spatial methodology,</p> <p>solving problems,</p> <p>geo-spatial information measurement, analysis, representation and interpretation</p>	<p>Intra- and interdisciplinary,</p> <p>multi-perspectivity</p>	<p>Professional identity,</p> <p>competent action,</p> <p>reflection,</p> <p>ethics of responsibility</p> <p>social responsibility</p>
Within DVWkon²-GEOS evaluated based on ...	External perspective	Internal perspective	Internal perspective	Internal perspective

FQR_GG was chosen as basis for the evaluation carried out in the frame of DVWkon²GEOS in order to support increased acceptance for the findings regarding the analysis of Geodesy-related study programs, which is – in the frame of increased motivation and commitment – a crucial success factor of change processes (Skoldberg 1994) like the further development of study programs resp. curricula. The expected most important FQR_GG-related success factors are:

- The FQR_GG is a compact (13 pages) document written in German language;
- the FQR_GG fits all university degrees (e.g., Bachelor);
- the FQR_GG is independent of the type of universities;
- representatives of all relevant target groups (e.g., universities, professional organizations) helped to create and ratified FQR_GG;

- FQR_GG promotes a strict constructive alignment (Biggs 2014) with respect to learning resp. qualification aims and competencies;
- the student-centered didactical approach of student-controlled research-based learning (Mieg 2019) is assumed to be applied.

Besides the chosen FQR_GG-based strategy for the evaluation of competencies in DVWkon²GEOS, within the international geodetic community significant effort is undertaken to establish and to contribute to professional discipline-specific definitions of knowledge, skills, attitude, and education (e.g., FIG 2004, Greenfield 2010). These approaches differ with respect to purpose (for example, accreditation (e.g., [ABET](#)), licensing (e.g., [NCEES](#))), level of detail (e.g., [GIS&T Body of Knowledge](#); Ahearn et al. 2013), and geographic focus region.

3. DVWKON²GEOS

The German Association of Surveying – Society for Geodesy, Geoinformation and Land Management ([DVW](#)) has the main objectives to promote and to elevate the diverse and complex field of surveying and related sciences in general. Therefore, the DVW incorporates scientific as well as practical expertise of its members in the disciplines of Geodesy, Geoinformation, and Land management. Any person, who is interested in supporting surveying can become a member of a state association of DVW. Active members contribute to the mission of DVW, for example, as elected members of seven [working groups](#) (e.g., Profession/Education, Geoinformation and Geo Data Management, Measurement Methods and Systems). The Working Group 1 (WG1) "Profession/Education" has approx. 20 members, which – based on their individual professional background, knowledge, and attitudes – support progress in the very broad field of works of WG1 (e.g., recruitment, public relation, education, professional ethics and professional identity, safety at work, diversity). In this process, WG1 benefits from the diverse professional perspectives of its members, representing public service, private sector, and education. One specific characteristic of WG1 is, that one representative of the Conference of Geodesy Students of German-speaking Universities (KonGeoS) is incorporated as guest member of the working group. KonGeoS is a growing network of young surveyors, which connects students, alumni, universities, companies, and professional associations all over the world (KonGeoS; Thiery & Fintzen 2020). This enables an important perspective, especially when dealing with future-readiness of study programs.

For the working period 2019-2022, WG1 has decided to develop a competency-based tool for the analysis of German-speaking Bachelor study programs. Therefore, within the WG1 project "DVWkon²GEOS" a digital process will be established based on a close and innovative cooperation between WG1 members representing university staff and students.

Besides geodetic expertise, expertise in the fields of higher education and change is represented within DVWkon²GEOS through the "Tandem for Educational Development" of the Department of Civil Engineering, Geo- and Environmental Sciences of KIT (Karlsruhe Institut of Technology, Germany), where Katrin Heß – employee of the Department of Educational Development – and the employee of the department Michael Mayer (head of DVW's project DVWkon²GEOS) are working closely together (Heß & Klink 2018). KIT's innovative tandem-approach synergetically meets diverse discipline-specific characteristics (Becher 1994) of universities, which have to be identified as "specific organizations" (Musselin 2007; Kehm 2013).

Representatives of specific organizations identify themselves more strongly with their discipline than with their institution. In general, the objective of KIT's tandem-approach is to create discipline-specific innovations in teaching and learning with a special focus on the support of the process of conceptual change in higher education (e.g., competency-based learning (Voorhees 2001), constructive alignment (Biggs 2014), and research-based teaching (Jenkins et al. 2007)).

Based on geodetic expertise and expertise in the field of higher education, the aims of the low-threshold and open-door project DVWkon²GEOS are:

- Increased standardization of the Geodesy-related study program analysis (assurance: analysis is carried out based on FQR_GG by DVWkon²GEOS);
- combination of internal and external perspectives on study programs (assurance: close cooperation between students and academic university staff within DVWkon²GEOS and close (e.g., transparent, traceable) collaboration between DVWkon²GEOS and analyzed study programs);
- acceptance of results and findings (assurance: application of methods of agile process management (www.agilemanifesto.org; Serrador & Pinto 2015), inclusion of students' perspective through members of the KonGeoS network, and inclusion of expertise in the field of higher education through the "Tandem for Educational Development" of KIT).

Therefore, DVWkon²GEOS will provide – in addition to the process of educational accreditation – information regarding the recent status of study programs especially focusing on (i) the acquired competences of graduates and (ii) the design of the curriculum as basis for the complex and continuous change process of further development of study programs. Thereby DVWkon²GEOS contributes to the future-readiness of the discipline Geodesy and specific study locations. In addition, DVWkon²GEOS supports and intensifies the networking throughout the geodetic community and contributes to a public discourse, and therefore helps to strengthen and sharpen the public perception of the discipline Geodesy. In addition, the exchange with respect to teaching and learning throughout the geodetic community is stimulated. In the following, the two most important aspects of DVWkon²GEOS are described and discussed. Section 3.1 deals with the internal perspective on acquired competencies gained especially through the inclusion of graduates of the study program under research, while section 3.2 deals with the external view on the curriculum of study programs, especially incorporating members of DVW WG1. Therefore – especially taking potential added value and practicability into account –, it was decided to receive feedback regarding methodological, social, and self-competencies from very recent graduates, while the analysis of professional competencies is carried out from DVWkon²GEOS and from responsible persons of study programs (e.g., dean of studies, study coordinator). To gain first experiences the analysis process within DVWkon²GEOS was applied to the German-speaking Bachelor study program "Geodesy and Geoinformatics" at the Karlsruhe Institute of Technology (BSc KIT-G&G).

Before in section 4 recent findings are going to be presented and discussed, in section 3.3 the feedback of members of WG1, who are not directly involved in DVWkon²GEOS, as well as graduates of BSc KIT-G&G is presented.

3.1 Internal perspective on methodological, social, and self-competencies

The most significant added value regarding competences, which are acquired from students during their studies at universities, is expected when graduates are inquired. Therefore, the description of all 14 methodological, social, and self-competencies (see Tab. 1) is presented to the graduates within KIT's learning management system [ILIAS](#). Using scale-based self-evaluation, each voluntary participating graduate estimates the level of competency acquirement anonymously. Hereby, the level discretization was chosen to five (Level 1: not at all; Level 5: entirely). In addition, graduates are allowed to skip the self-evaluation of a specific competency. In addition to the FQR_GG-based inquiry, the graduates are asked concerning ...

- ... individual competency level of the future competency (UNESCO 2017) digitality;
- ... individual competency level of interdisciplinarity;
- ... number of oral presentations (minimum length: 10 minutes) given during their university studies;
- ... number of written reports (minimum length: 10 pages) prepared during their university studies;
- ... three most important individual highlights of their university studies.

The duration of one ILIAS-run is approximately 10 minutes. The usage of ILIAS guarantees archiving of data as well as autonomous data analyses and presentation. In order to motivate the graduates to contribute to DVWkon²GEOS, the individual self-evaluations are provided to the students with respect to the mean values and standard deviations of the entire data base of their associated study program, enabling the graduates to rank their own competency acquirement levels with respect to the levels of other participants.

3.2 External perspective on discipline-related professional competencies

In addition to the internal perspective on methodological, social, and self-competencies, FQR_GG provides various domains (see Tab. 1), wherein Geodesy-related competencies can be acquired. The specific characteristics of study programs in these domains are very important for the decision process of future university students (e.g., which study program resp. study location has to be chosen?). Therefore, DVWkon²GEOS attached a high priority to the external perspective on Geodesy-related characteristics of study programs supporting the comparison resp. differences of study programs. To represent the external view on study programs the official catalogue of modules is analyzed by three members (Julius Fintzen, Michael Mayer & Florian Thiery) of DVWkon²GEOS (duration: individual analysis: approx. 90 minutes, final joint online discussion: approx. 60 minutes). As basis for this domain-specific analysis ECTS credits are utilized. The result consists of a table wherein a discrete number of ECTS credits is associated to each domain. In addition, for study programs under research is checked, ...

- ... if a pre-university internship is a pre-condition for the enrollment;
- ... how many ECTS are associated to compulsory/elective lectures;
- ... how many ECTS credits students have to invest in key competences;
- ... how long the standard period of study is;
- ... if a practical semester is regular part of the study program;
- ... how many ECTS credits are assigned to the Bachelor thesis.

For the study program under research responsible persons are asked to carry out the analysis on their own. Based on this information, the study programs are able to compare the outside perception to the self-perception, when realizing differences and congruence.

This approach enables a transparent comparison between study programs, and provides therefore important pre-university decision-related information and additionally is of great interest for the labor market; for example, unique characteristics of study programs (e.g., specialization subjects) are detected reliably. With the consent of study programs, a compilation of the external perspectives will be provided through the KonGeoS website (www.kongeos.de), since it is expected that students considering the change of their study program resp. location, and pupils resp. future university students check out this website.

3.3 Feedback from DVW WG1

According to the continuously carried out change process of study programs, DVWkon²GEOS is defined as an ongoing process, too. In order to guarantee best possible fitting regarding the main goals of DVWkon²GEOS, feedback is requested as often as possible. Within DVWkon²GEOS three members of WG1 are representing the project team, therefore all other WG1 members are important feedback resources. Within DVWkon²GEOS feedback questionnaires as well as oral and online feedback is used for process adjustment and optimization. Based on discussion within WG1 it was decided to ...

- ... include information regarding the admission to the legal traineeship for geo-spatial authoritative positions;
- ... include information regarding Bachelor study programs only, Master resp. Diplom study programs will not be taken into account.

4. RECENT FINDINGS AND NEXT STEPS

The first experiences within DVWkon²GEOS were gained in BSc KIT-G&G during winter semester 2019/20. Therefore, after having a briefing with the dean of studies, in order to ask for permission, very recent graduates were asked to perform the inquiry described in section 3.1. Analyzing the mean values (over-all mean: 3.7; maximum: 4.5; minimum: 2.7) of all competency acquirement levels and their standard deviations (minimum: 0.0; maximum: 1.7), the persons in charge can easily identify critical competencies. At BSc KIT-G&G, an over-all high competency acquirement level could be identified (e.g., more than 55% of all individual self-estimations resulted in Level 4 or higher), while in particular the self-competencies related to ethics of responsibility and professional self-identity have to be considered more prominently in BSc KIT-G&G in the future, if a better fitting to FQR_GG is aspired.

In addition to the analysis of the results of the inquiry, the comparison of the qualification aims of the study program and the competencies listed in the FQR_GG can generate important tasks for the further development of study programs and support a more rigorous transformation process to a Bologna-related study program.

During the BSc KIT-G&G analysis regarding the external perspective on discipline-related professional competencies (section 3.2), it could be realized, that the analysis strategy regarding the catalogue of modules (containing information regarding lectures, modules, and subjects)

was handled different within DVWkon²GEOS (subject-related analysis) and in the study program under research (module-related analysis). This ends up in analysis differences, especially when there is no congruence in the subjects of the study program and the treated domains of FQR_GG. For BSc KIT-G&G, this comparison emerged divergence especially with respect to the domain of engineering Geodesy. In addition, within BSc KIT-G&G – in contrast to the framework FQR_GG – lectures resp. modules enabling the acquirement of competencies related to legal framework are missing.

These findings regarding the first application of the DVWkon²GEOS strategy to a study program proof, that both parts of DVWkon²GEOS – regarding the internal and the external perspective – are able to generate valuable feedback and provide good starting points for the further development of study programs. In order to guarantee transparency for the study program under research, the determined results and gained insights will be presented to and discussed with the commission of studies stimulating the further development of BSc KIT-G&G (duration: approx. 60 minutes).

All online elements of DVWkon²GEOS are provided using ILIAS, which is well-known to KIT graduates. In the further process of DVWkon²GEOS it is planned to analyze the German-speaking study program “Applied Geodesy” of Jade University of Applied Sciences (Oldenburg, Germany). This university uses [moodle](#) as learning management system. Therefore, a tutorial has to be compiled supporting a smooth self-evaluation flow.

First experiences of DVWkon²GEOS could be gained at KIT-G&G, due to excellent personal contacts. In Oldenburg, excellent prerequisites are given, too. This guarantees high acceptance during the analysis of the study program as well as high impact on the further development of the study programs. In order to establish trusting cooperation to further study programs without personal contacts low-threshold facilities (e.g., presentations at conferences, flyers) will be used.

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BIOGRAPHICAL NOTES

Dr.-Ing. Michael Mayer received his doctoral degree in 2005 from the Karlsruhe University (TH), when he was researching the appropriate GNSS modeling of the deformation network Antarctic Peninsula. He is actually the discipline-specific part of the Tandem for Educational Development at the Department of Civil Engineering, Geo and Environmental Sciences of the Karlsruhe Institute of Technology (KIT) and active member of working group 1 “Profession/Education”, German Association of Surveying (DVW).

Florian Thiery M.Sc. received his Master of Science degree from the Hochschule Mainz University of Applied Sciences in 2013. From 2014 to 2018 he worked at the Institute of Spatial Information and Surveying Technology (i3mainz). From 2016 until now he is working at the IT department of the Römisch-Germanisches Zentralmuseum, Leibniz research institute for archaeology. He is part of the “DVW working group 1 Profession/Education” and is researching in his free time on Linked Data structures for Ogham inscriptions within the Research Squirrel Engineers group.

Julius Fintzen is currently studying “Applied Geodesy” (B.Sc.) at Jade University of Applied Sciences (Oldenburg, Germany). After a practical training, he will start his bachelor thesis in summer 2020. He is active member of the board of the Conference of Geodesy Students of German-speaking Universities (KonGeoS), responsible for clubs and associations, especially DVW. Since 2019 he is guest member of the “DVW working group 1 Profession/Education”.

Dipl.-Ing. Monika Przybilla received her University Degree in Geodesy based on studies at RWTH Aachen and Bonn University. She is project manager “Geoinformation Systems” at the Regional Association Ruhr (RVR) and a long-term active member of the DVW working group 1 “Profession/Education”; since 2015 she is chair of this working group.

Dipl.-Inform. Katrin Heß received her university degree in Computer Science from the Karlsruhe Institute of Technology (KIT) in 2013. From 2013 until now she works at KIT’s business unit “Human Resources Development and Vocational Training”. Her main focus is on higher education didactics. She is actually also responsible for the didactic part of the Tandem for

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