# Analyzing the motivation and expectations of the next generation of Geodesy students in German-speaking countries

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**Key words**: DACH (Germany, Austria, Switzerland), geodetic education, Conference of Geodesy Students of German-speaking Universities (KonGeoS), first semester students, survey, university, young surveyors

## SUMMARY

With a view at the long-term development of student numbers, this study attempts to gain an insight into the motivation of German-speaking first-year students in geodesy and surveying. With the help of a first-semester survey, which is carried out annually by the conference of Geodesy Students of German-speaking Universities (KonGeoS) in cooperation with the majority of German-speaking universities, an insight was gained about the motivations for taking up the study program, previous experiences and also the plans of the students for the future, mainly regarding professional career prospects. The survey has been evaluated for the year of 2022 as well as previous years going back to 2013. This paper attempts to frame certain key points that seek to narrow down the requirements and expectations of those starting their professional career in the coming years, as they will play an essential role in the future development of institutions and commercial enterprises. A deepend focus is placed on ways to encourage high-school graduates to enroll to a geodesy program at German-speaking universities.

This paper first tries to shed light on the development and the current situation on the German-speaking labor market with a focus on the field of geodesy. In addition, the situation at the German-speaking universities is discussed. Up next is the presentation of the research methodology used for the following analysis, which introduces the used data of the first semester student numbers and the annual KonGeoS-survey, conducted at numerous universities in Germany, Austria and Switzerland. These data were then used in the following section, in combination with previous work from the literature, to analyze development of the past decades, concerning both the labor market as well as the situation at the universities. Finally a conclusion is drawn considering the findings of the analysis.

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## 1. INTRODUCTION

In Germany, Austria and Switzerland, there are a total of 24 universities and universities of applied sciences offering surveying-related courses of study. KonGeoS, the association of 22 surveying student councils from these three countries, has taken on the task of bringing the students from these universities together for a meeting every semester, i.e., every six months. The focus of these meetings is the professional as well as the interpersonal exchange. In addition, there is a lot of discussion about the similarities and differences between the study programs and the various universities. Another task of the organization of KonGeoS is to bring the students together with the relevant associations and organizations of geodesy, as well as with potential employers. This is especially carried out through the work of the board, which is elected at the meetings by the member departments. Other important aspects here are furthermore the public relations and the recruitment of young surveyors. Therefore, KonGeoS does a survey among new students once a semester to see how many new students there are and what motivated the new students to take up the program. This not only generates important numbers, but also allows for the effectiveness of PR campaigns. These statistics are then shared with the universities, as well as various societies and organizations that are involved in surveying. In this way, they can react to them and target their advertising more specifically to young people. In the following, both the job market and the course of study are considered. In doing so, the numbers of students, surveying technicians and surveying engineers from the three countries are compared and evaluated from the past years.

## 2. BACKGROUND

With the demographic change in the German speaking countries becoming more and more visible and the lack of skilled workers becoming more and more urgent, this paper starts with a general overview of the German labor market and further gives an introduction into the German system of higher education for the field of geodesy.

### 2.1 Development of the labor market

With the average birth rate per woman in Germany shrinking from 1.92 children per woman in 1990 to 1.53 children per woman in 2021 (Statistisches Bundesamt, 2022a) and the immigration of young professionals stagnating, the supply of young workers is decreasing (Mergener, 2021). At the same time the generation of the baby boomers is retiring. It is estimated that by the year of 2036 12.9 million workers will have reached the retirement age. This accounts for around 30

percent of the total German workforce. As shown in Table 1, the total workforce is estimated to decline: 8.2% between 2019 and 2030 and a further 5.3% until 2030. The total number of workers shall decline from 43.6 million in 2019 to 40 million by 2030 and further to 37.7 million by 2040. The median age is projected to stay stable around 44 years indicating a loss of mainly older workers retiring. The activity rate is estimated to fall from 70% to 66% following a general trend to work less (Statistisches Bundesamt, 2022b).

| | **2019** | **2030** | **2040** | **2050** | **2060** |
|---|---|---|---|---|---|
| **Workers in1000** | 43,570 | 40,011 | 37,687 | 35,767 | 33,299 |
| **Percentage** | 100 | 91.8 | 86.5 | 82.1 | 76.4 |
| **Median Age** | 44.4 | 43.7 | 44.5 | 44.0 | 43.0 |
| **Activity Rate %** | 70 | 66 | 66 | 66 | 65 |

**Table 1:** Projection of the German workforce including total number, median age and activity rate considering low migration (Statistisches Bundesamt, 2020)

There is no official data for the field of geodesy. Only one survey was conducted among geodesist employing companies in North Rhine-Westphalia in 2011. Figure 1 shows the annual loss of workers, the need for new workers and the estimated number of new degree holders per year for the time 2012-2017. For Bachelor and Master graduates, there is a significant gap between the number of workers needed and the number of graduates indicating a further aggravation of the lack of skilled workers (Oestereich, 2012).

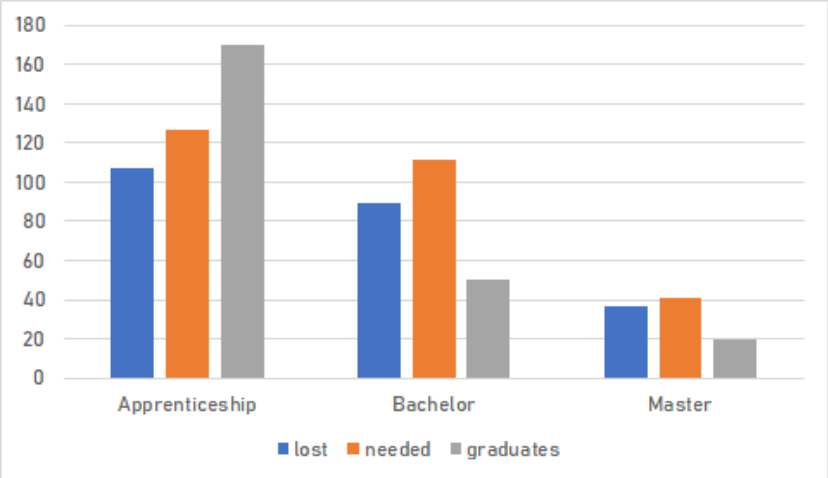
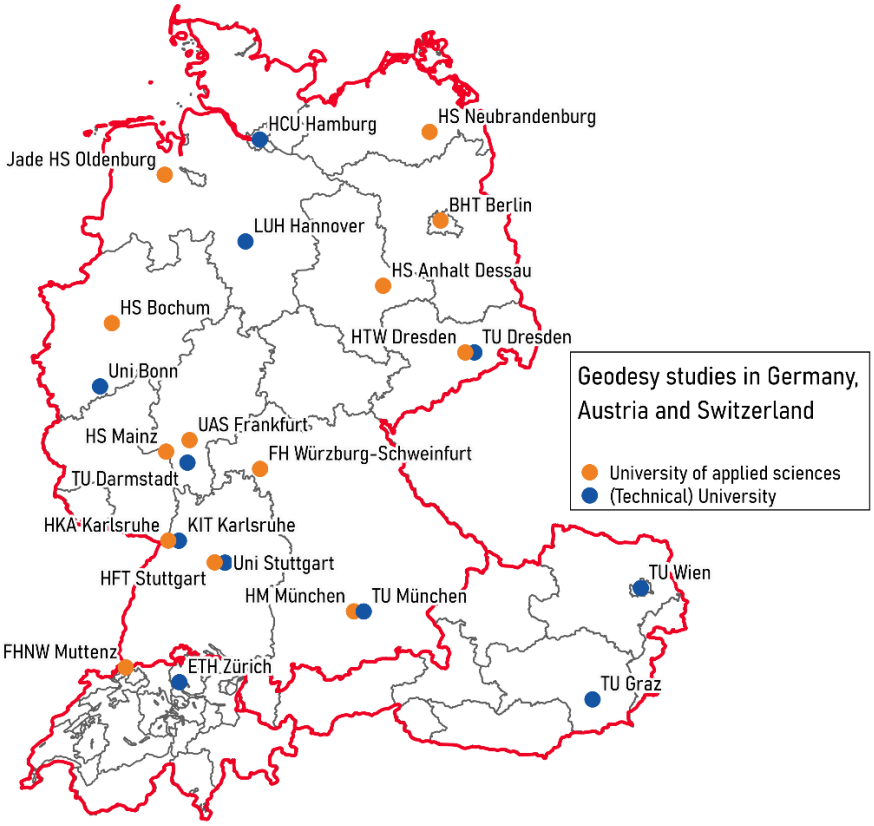



**Figure 1:** Annulary lost and needed workers, annulary graduates in North Rhine-Westphalia (Oestereich, 2012)

There only seem to be enough geodesists graduating with an apprenticeship. This number is misleading though as a lot of them will continue to get a Bachelor's or even Master's degree (Oestereich, 2012).

## 2.2 Geodesy studies at German-speaking universities

In contrast to many other countries, there are multiple types of universities in the German-speaking countries. Thus, there are also different types of universities that offer study programs in surveying and geodesy. These often differ not only in their focus on teaching and research, but also in the degrees they offer their students. For many years, an eight-semester course of study at a university of applied sciences ("Fachhochschulen") led to the degree of "Diplomingenieur (FH)" (Dipl. Ing.(FH)), while the usually nine-semester course of study at (technical) universities, with an in-depth focus on fundamental education in mathematics and the natural sciences as well as subject-specific in-depth education, led to the broader degree of "Diplomingenieur" (Dipl. Ing.). During the course of the Bologna-Process, which was adopted in 1999 and implemented by 2010 at the latest, and which aimed for standardization of university-degrees in 29 European countries, degrees in geodesy and surveying were also reorganized. Six-semester Bachelor of Science (B. Sc.) programs in geodesy and geoinformatics have been introduced at universities. In addition, consecutive three- or four-semester programs leading to the Master of Science (M. Sc.) degree were introduced. The former "Diplomingenieur" degree was given the same status as the M.Sc. degree.




At universities of applied sciences, seven-semester Bachelor of Engineering (B. Eng.) degree programs were created with a greater focus on practical training. Furthermore, Master of Engineering (M. Eng.) programs were created. The old "Diplomingenieur (FH)" degree was deemed equivalent to a Bachelor's degree, despite actually being a higher-level qualification, as it did not correspond to the Master's level (Kleusberg & Wehmann, 2006).

**Figure 2:** Universities in German-speaking countries that offer geodesy studies programs. (KonGeoS, 2023 & Arbeitsplatz Erde, 2023)

Today, as shown in Figure 2, there are a total of 24 universities and universities of applied sciences in German-speaking countries that offer a degree in a program typically called "geodesy and geoinformatics". All of these offer both a Bachelor's and a subsequent Master's degree (Konferenz der GeodäsieStudierenden, 2022). Typically, all programs at German-speaking universities include fundamental training in mathematics, physics, statistics, computer science, classical surveying, GNSS, laser scanning, photogrammetry, remote sensing, and geoinformatics. Special focus is placed on the tasks of cadastral surveying, spatial planning and the associated legal principles, which are essential for working in many areas of geodesy (Illner et al., 2018). At universities of applied sciences, there are furthermore longer periods of practical training integrated into the course of study, as well as a large number of projects and practical exercises, while at universities there is a greater focus on theoretical aspects and further specialization, for example in physical geodesy, hydrography, geodetic earth observation or industrial metrology (Illner et al., 2018 & HafenCity University Hamburg, 2023). As a result of the COVID19 pandemic, all courses were conducted fully or at least partially online for up to four semesters. However, as this was not feasible for all courses, some courses, mostly practical exercises but also individual lectures, were postponed or even completely canceled (Mayer et al., 2021).

## 3. RESEARCH METHODOLOGY

This section will present the research methodology used in the following analysis. First, the methods used to evaluate the number of first-year students will be discussed. This is followed by the approach used to evaluate the annual KonGeoS survey.

### 3.1 First semester student numbers

Every year, the Federal Statistical Office publishes statistics on student numbers for Germany, distinguishing between the various courses of study and the respective semester of the enrolled students. Table 2 shows the values for surveying and geodesy related study programs at German universities (UNI) and universities of applied science (UAS) for a ten year period starting from the winter semester 2012/13, published by the Federal Statistical Office of Germany.

| | **WiSe 12/13** | **WiSe 13/14** | **WiSe 14/15** | **WiSe 15/16** | **WiSe 16/17** | **WiSe 17/18** | **WiSe 18/19** | **WiSe 19/20** | **WiSe 20/21** | **WiSe 21/22** |
|---|---|---|---|---|---|---|---|---|---|---|
| **UNI** | 1012 | 1660 | 1323 | 1340 | 1209 | 1080 | 1109 | 1103 | 927 | 857 |
| **UAS** | 1452 | 1661 | 1754 | 1992 | 1858 | 1802 | 1764 | 1476 | 1426 | 1224 |
| **Total** | 2464 | 3321 | 3077 | 3332 | 3067 | 2882 | 2873 | 2579 | 2353 | 2081 |

**Table 2:** First semester student numbers for all German universities (Statistisches Bundesamt, 2012-2021)

In the case of Austria and Switzerland, the necessary data had to be obtained directly from the universities. Since there are only universities in Austria where surveying or geodesy can be studied at, no sum of all students is built. In the case of Switzerland, there is both a university and a university of applied sciences, but for the University of Applied Sciences of Northwestern Switzerland (FHNW), all first-semester numbers were only available starting from the 2019/20 winter semester. Table 3 shows the first-semester numbers for Austria and Switzerland.

| | **WiSe 12/13** | **WiSe 13/14** | **WiSe 14/15** | **WiSe 15/16** | **WiSe 16/17** | **WiSe 17/18** | **WiSe 18/19** | **WiSe 19/20** | **WiSe 20/21** | **WiSe 21/22** |
|---|---|---|---|---|---|---|---|---|---|---|
| **UNI AT** | 110 | 137 | 146 | 82 | 80 | 82 | 78 | 67 | 74 | 81 |
| **UNI CH** | 67 | 65 | 62 | 53 | 61 | 73 | 75 | 80 | 84 | 98 |
| **UAS CH** | | | | | | | | 44 | 30 | 35 |
| **Total CH** | | | | | | | | 124 | 114 | 133 |

**Table 3:** First semester student numbers for all Austrian and Swiss universities (ETH Zürich(2021)), FHNW(2013-2021), TU Wien (2022), TU Graz (2022))

### 3.2 The annual KonGeoS-survey

As part of the conference of geodesy students (KonGeoS), the working group "Young Surveyors" meets every six months. There, students from the various universities report on their experiences and observations of student number development, as well as the situation of the study and teaching and discuss possible measures. To also get an overall view of the situation and to determine the experiences of the students themselves, a first semester students' survey is conducted at the beginning of each semester. The questionnaire is updated within the framework of the working group. There are two different versions of the survey addressing bachelor's and master's students. This work will mainly focus on the bachelor's survey.

This survey is distributed to the student councils of all universities participating in the conference. Results of this survey are available for a period of ten years, beginning with the founding of the KonGeoS in 2012. As the responsible party within the conference, this survey will be sent to the student councils of the KonGeoS member universities with a request on the implementation of the survey in the context of the first semester introduction. Since these contact persons are also students and thus are replaced approximately every three years, continuous feedback is a challenge. It regularly happens that there is no response from some universities. During the pandemic, significantly fewer students participated. The number of responses also fluctuates in general. Because of this, the results of this survey have to be analyzed carefully, but nevertheless provide important insights into the development of the new generation of surveyors.

This survey is unique in the German-speaking area in the field of geodesy in this form. This results in great interest, both from educational institutions and associations, as well as from large and small companies in the fields of surveying, geodesy and geoinformatics. In addition to person-related information, such as age or whether previous training in the subject has been completed, questions about the first point of contact with the industry and the motivation to study geodesy are of particular interest. In addition, plans for the future are questioned, e.g. whether a subsequent master's degree is planned or in which area the person would like to work after graduation.

## 4. RESULTS AND DISCUSSION

The evaluation and interpretation of the information collected is addressed in the following section. First, the progression of first-semester student numbers in geodesy is considered. In the following, these numbers are discussed and a first outlook is provided. In addition, the annual KonGeoS survey is analyzed and more information about the background, motivation, and future of geodesy students will be considered.

### 4.1 First semester student numbers

In Germany, the number of first-semester students in the last decade reached its highest level in the years 2014 to 2016. Since then, the number of students at German universities and universities of applied sciences has been declining. Figure 3 also shows that this trend continues during the COVID-19 pandemic. Thus, the student numbers in the winter semester 2021/2022 were the lowest observed during the last decade. In total, slightly more than 2000 students have started at German universities and universities of applied sciences in the winter semester 2021/2022. Universities account for around 41% and universities of applied sciences for 59%. This ratio has remained almost constant in recent years.

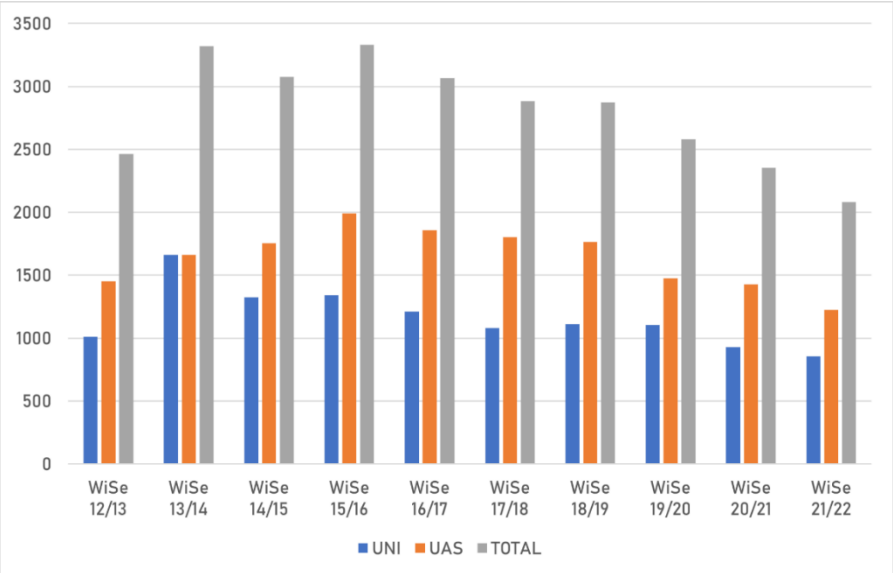



**Figure 3:** First semester Geodesy students in Germany. (Statistisches Bundesamt, 2012-2021)

For some years now, universities and universities of applied sciences have recognized the decline in student numbers. Professional associations, authorities, engineering and specialized companies have also become aware of this trend. As a result, actions and campaigns have been launched to raise awareness of the geodesy profession and to recruit high school graduates, as well as graduates of apprenticeship programs to start a bachelor program in geodesy. Despite these efforts, no trend reversal could be achieved so far in Germany. In order to be able to meet the high demand of the labor market for specialists in geodesy in the future, it seems to be important to have increasing student numbers in Germany soon. Geodetic study programmes are becoming smaller in Germany due to declining student numbers. So it becomes difficult in the long term to justify the many study locations where geodesy is taught if the number of students continues to fall in the future.

At the two Austrian universities in Vienna and Graz, the numbers of new students were relatively high in the years 2012 to 2014. Figure 4 shows more than 100 new geodesy students starting in the winter semester of 2012. In the winter semester of 2014, there were even more than 140. In the following years, the numbers were at a significant lower level.
Since the winter semester 15/16, about 80 students enroll in geodesy at Austrian universities every year. Because of the development of the student numbers in recent years, constant numbers in the near future can be expected. However, it would be better if the number of students in Austria would increase again in the next few years.

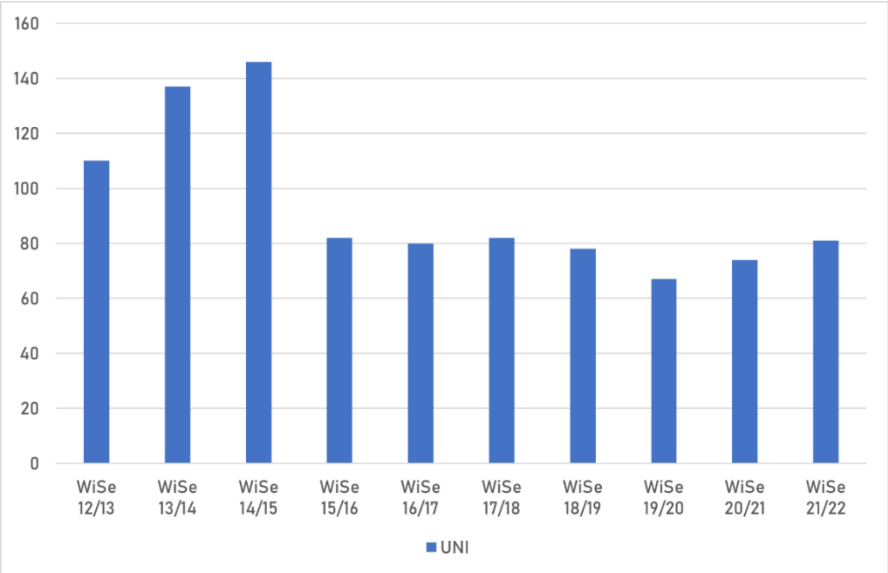



**Figure 4:** First semester Geodesy students in Austria (TU Wien, 2022 and TU Graz, 2022)

A different development can be seen at the German-speaking universities in Switzerland. Figure 5 shows the development at the technical university in Zurich (ETH Zurich) and the university of applied sciences in Muttenz (FHNW). Here, a positive trend can be seen for student numbers of ETH Zurich. Until winter semester 2015/2016, the numbers are slightly declining. But since then, significantly more students started in geodesy every year. Even during the COVID-19

pandemic, the numbers have continued to rise. For example, in recent years, about 120 students have consistently started at ETH Zurich and FHNW, with nearly 100 first-semester students at the Zurich technical university alone. The majority of about 70% are at ETH Zurich and the remaining 30% belong to FHNW. Such a positive trend is needed to bring a sufficient number of new surveyors to the Swiss labor market.

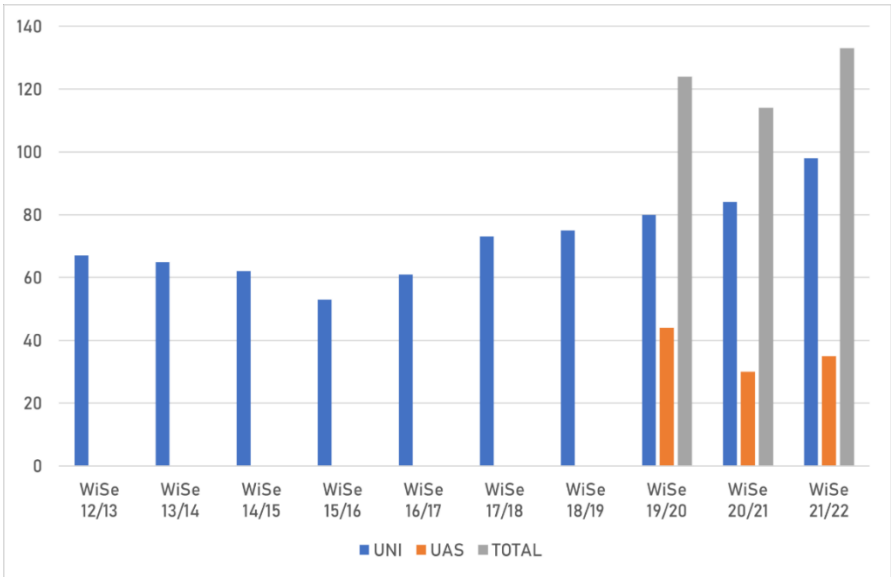



**Figure 5:** First semester Geodesy students in Switzerland.
(ETH Zürich 2021 and FHNW 2013-2021)

It should also be mentioned that usually only a certain percentage of new enrolled students are able to successfully complete their studies. The number of new enrolled students should therefore not be equated with the number of graduates.

It is significant to note that the development of student numbers in Germany, Austria and Switzerland differs considerably. While the numbers in Germany are decreasing and remaining rather constant in Austria, there has been a growth in Switzerland in recent years. But all countries have one thing in common, they want to build a strong generation of young surveyors with high student numbers and well-qualified graduates and thus be well prepared for the future in geodesy. In order to achieve this, many efforts are being made to bring geodesy more into the public eye and especially to reach the target group of high school students.

### 4.2 The annual KonGeoS-survey

The most recent iteration of the annual KonGeoS survey was conducted in October 2022 and comprised 304 first-semester students from 17 out of 22 member universities of KonGeoS. The remaining 5 universities did not provide a response.

This section will address the following questions of the survey in particular:

- How did the students find out about the study programme?
- Do the students work while studying?

- Have the students completed an apprenticeship before starting their studies?
- What are the students' expectations for their future after graduating, regarding the field of work and the employer? Do they plan to start a master's degree afterwards?

The first challenge presents a fundamental issue: Surveying does not have the same level of recognition as other disciplines (e.g. Business Administration, Law) and often requires explanation. This is why the first-semester students were asked about their prior exposure to geodesy and surveying and the reasons behind their choice of this academic program. Respondents were allowed to provide multiple answers.

As depicted in Figure 6, a substantial number of students were introduced to the academic program through relatives, acquaintances, and general websites, as well as through their school or future employers in surveying offices or companies. Campaigns and initiatives, some of which are supported by professional associations, have not had the desired impact.

Professional associations tend to play a limited role in promoting the field and related training programs. Information events and action days are typically limited in scope and reach fewer young people compared to general websites. Some social media channels are still under development and may have a greater impact in promoting geodesy in the near future. The "weltvermesserer" campaign, which was launched in August 2020, is seen as a source of hope for many institutions, although few first-semester students cited it as a reason for pursuing geodesy studies. Personal contacts, in addition to potential future employers, continue to have the most significant influence on students' decisions to study geodesy.

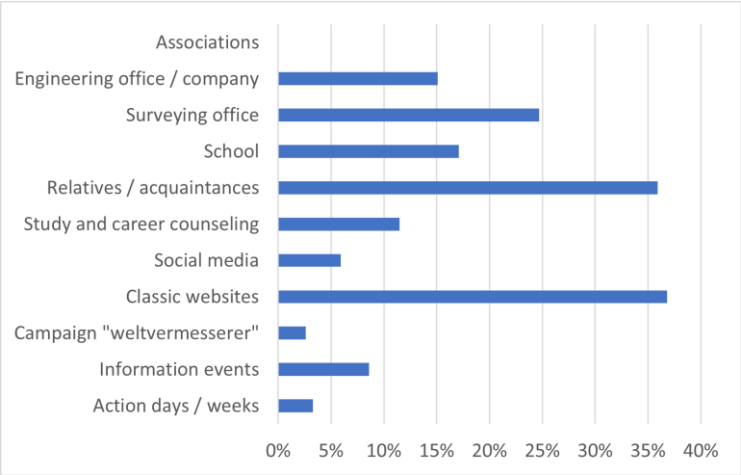



**Figure 6:** Students' points of contact with Geodesy according to the KonGeoS-survey (Total of 304 participants)

The next aspect of the survey focused on the number of students who are employed while studying, with a particular emphasis on whether they work in the field of surveying.

Figure 7 provides a visualization of the students' employment status during their academic program. 57.8% of the participating students hold jobs alongside their studies and 41.9% are employed in the field of geodesy. While working students are primarily hired for labor purposes, companies see dual students as their future workforce and provide support for their professional development. In both cases, students gain practical experience in their field of study while also financing their education. The survey results indicate that many first-semester students are interested in this type of work arrangement, and that companies and offices are increasingly willing to participate. Through the dual student model, they hope to secure the services of skilled young professionals for long-term positions prior to their entry into the workforce.

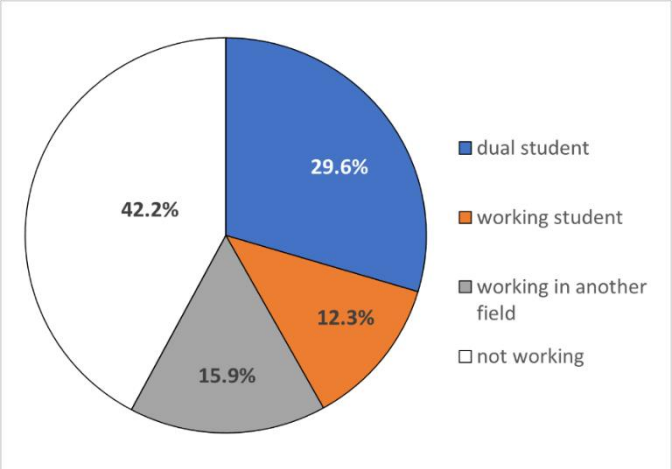



**Figure 7:** Working status of Geodesy students according to the KonGeoS-survey (Total of 304 participants)

Students who have completed an apprenticeship in the field of surveying have received a more specialized technical education in the subject, although it is not a requirement for enrollment. The survey also included a question about prior completion of an apprenticeship.

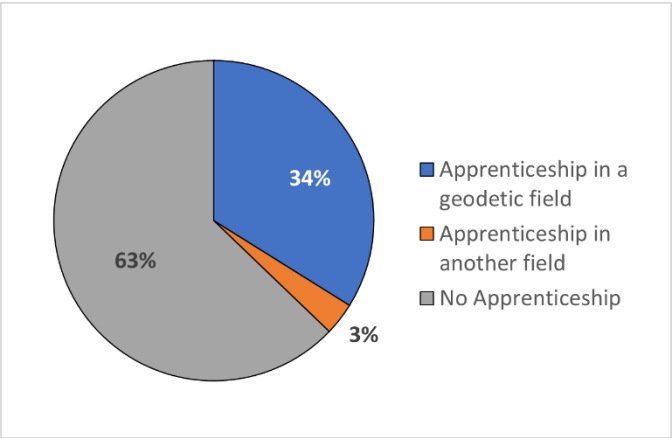



**Figure 8:** Students with a previous apprenticeship according to the KonGeoS-survey (Total of 304 participants)

Figure 8 presents the results of this question. Approximately one-third of the students had completed an apprenticeship in the field of geodesy prior to their academic studies. Only a small number of them changed their field of study from their previous training. Given the high demand for higher education in the form of university studies, it raises the question of whether an increased number of apprenticeships would lead to a higher enrollment in the academic program.

Further education opportunities, such as obtaining a Master's degree, were also explored in the survey. 20.4% of the participants answered "yes" to pursuing a Master's degree, while 21.7% answered "rather yes". Only 6.3% indicated that they were certain that they would not continue with a Master's degree, while 17.8% answered "rather not".

The choice of degree also depends on the desired profession after graduation. The survey addressed this by asking two more specific questions: one about the desired future employer and one about the desired field of work. Multiple options were again allowed for both questions. As shown in Figure 9, half of the students expressed an interest in working in the public sector. Engineering offices and working as cadastral surveyors were also popular among students. In contrast, self-employment, jobs at universities, software companies, and positions in the industry play smaller roles in the plans of first-semester students.

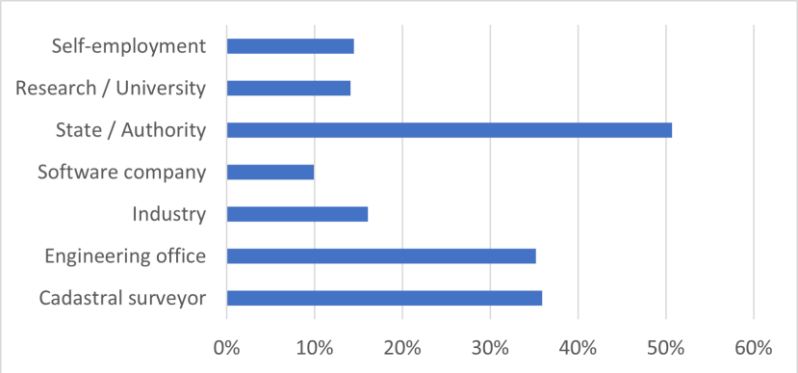



**Figure 9:** Target employments of first semester bachelor's students according to the KonGeoS-survey

Employment with the state or local government offers greater job security and regular working hours. Obtaining a Master's degree is particularly advantageous in this regard, as it impacts the level and classification of pay based on qualifications. Figure 10 shows the results of the related follow-up question. Two-thirds of the students envisioned themselves working as classic surveyors. Conversely, mechanical engineering, BIM, and land consolidation had lower popularity among students, and hydrography was not very attractive to them

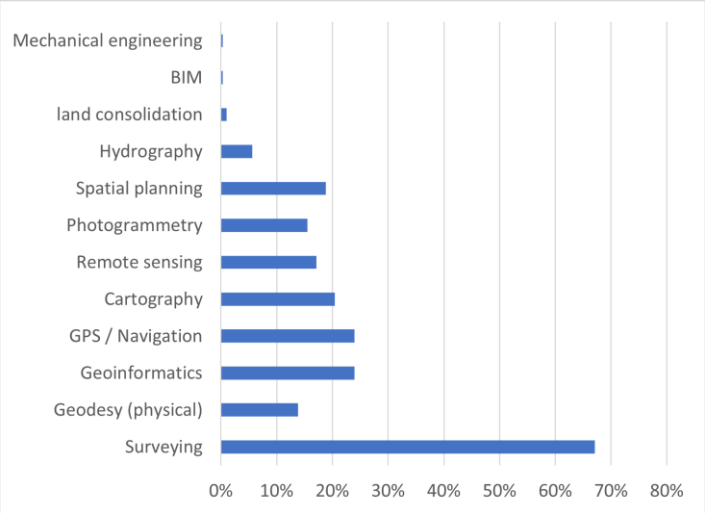



**Figure 10:** Target working fields of first semester bachelor's students according to the KonGeoS-survey

The popularity of engineering offices and public appointed surveyors aligns with the result of the second question, where classic surveying is more favored than more contemporary fields. This can be attributed to the initial perception of first-year students regarding their studies, which typically centers around classic surveying. However, as they progress through their studies, they may become more familiar with areas such as remote sensing or BIM, which are taught to varying degrees at different universities. It is worth noting that surveying is a subject that is taught comprehensively across all universities, but hydrography is only offered at a few universities near coastal cities.

## 5. CONCLUSION

In general, Germany has difficulties in finding qualified workers. One reason for this is the declining birth rate. The surveying sector is also struggling with this problem. Although there are enough surveyors with a completed apprenticeship, there are too few students at universities of applied sciences and universities. And the number of these are still increasingly declining in Germany. But that may also be partly due to the Corona pandemic. The number of students in Austria are relatively stable, and in Switzerland, they have risen in recent years.
The declining numbers have been observed for some time, and many attempts have been made to respond, but so far without great success. For this reason, among others, KonGeoS also conducts a survey every semester to ultimately determine how to attract the next generation of geodesists in the future. Even though this survey is not one hundred percent reliable because not all students participate, some conclusions can be drawn from it.
In the future, the profession needs to be brought further into the public eye to make it better known and to ensure that the programs at the different universities continue to be provided nationwide. The conference of German-speaking geodesy students - KonGeoS hopes to be able to contribute to this.

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