

On the Status of Geodetic Education in Germany during the COVID-19 Pandemic

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Keywords: Education of surveyors; COVID-19 pandemic; Online survey; Dual education; Higher education

SUMMARY

The professional association ‘German Association of Surveying – Society for Geodesy, Geoinformation and Land Management (DVW)’ has the main objective to promote and to elevate the diverse and complex field of surveying as well as related sciences in general. Its working group 1 (WG1) is focussing on profession and education. In order to gather representative and meaningful insights into the effects of the first wave (March–July 2020) of the COVID-19 pandemic, WG1 carried out an extensive online survey (approx. 1.500 participants, 25 questions) on the surveying-related education system in Germany. This education system is divided into (i) dual education and (ii) higher education. The dual education system combines apprenticeships in a company and vocational education at a vocational school, while higher education is carried out at universities. Both career pathways as well as the individual professional development ‘legal traineeship for geo-spatial authoritative positions’ were taken into account in the survey. As the education of young surveyors is carried out in classical classroom settings and intensive practical training, significant impact due to the COVID-19 pandemic was expected, due to government regulations and further guidelines of the educational institutions especially.

Within the paper, the database of the online survey is described in detail. The design of the survey enables to distinguish between the perspectives of young surveyors and teachers. To assess the effect of the COVID-19 pandemic, we compare their perceptions regarding, for example, working from home, communication processes, teaching and learning settings, completeness of education programs, exams, and level of satisfaction.

In contrast to well-planned online teaching, the current strategy of education systems with respect to COVID-19 is described as emergency remote teaching. Besides important conclusions regarding recent experiences of emergency remote teaching, COVID-19 significantly supported the further development of e-learning for instance through the digitization of teaching as well as learning processes. Hence the online survey focused on the future of teaching and learning, aiming to present the individual views of the participants on this future-oriented change process.

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1. INTRODUCTION

On the 27th January 2020, the first case of a COVID-19 infection was detected in Germany (RKI 2020). Since that date, Germany was unexpectedly affected by this very serious and highly dynamic global pandemic showing as well regional infection variations as effects on all areas of life.

This paper focuses on the effect of the COVID-19 pandemic on the education of young surveyors in Germany. Within this paper, FIG's definition of a surveyor is used (FIG 2021). This definition is quite broad and includes all aspects of surveying, geodesy, real estate, planning, and geoinformatics.

The basis of this paper is an online survey, which was carried out during October and November 2020 (beginning of the second COVID-19 wave) by the multi-perspective Working Group 1 'Profession/Education' of the professional association 'German Association of Surveying' (DVW e.V.). Therefore, the survey comprises the phase of the fast increase of infections in March and April 2020 (first COVID-19 wave), the closing of educational institutions (e.g., school providing vocational education, universities) and light loosening of strict regulations of federal and state ministries.

When discussing the effect of COVID-19 on educational institutions, the continuously ongoing change process (Burke 2018) of the megatrend 'digitization' – meeting the dynamic and globalized demands of society, research community, and labor market – has to be taken into account, too. At the same time, there are interactions with other megatrends (e.g., globalization, individualization, connectivity, knowledge culture) that can be experienced in teaching and learning contexts. Within this change process of digitization, surveyors act as pulse generators and process designers based on their unique digital competencies. Thus the analysis of the effect of the COVID-19 pandemic on the education of young surveyors is of particular importance.

Section 2 of the paper gives an overview of the activities of the professional association DVW during the COVID-19 pandemic. Section 3 is dedicated to the detailed survey on the education of young surveyors under COVID-19 circumstances comprising the time span March till October 2020. Since different pathways of education are offered to young surveyors in Germany, the surveying-related education system is shortly described in the beginning of section 3. Section 4 summarizes the most important aspects of the paper, which closes with a short outlook.

2. ACTIVITIES OF THE GERMAN ASSOCIATION OF SURVEYING DURING THE COVID-19 PANDEMIC

The professional association ‘German Association of Surveying – Society for Geodesy, Geoinformation and Land Management’ (DVW 2021) has the main objectives to promote and to guide the further development of 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. 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).

Based on DVW’s expertise and in order to support its members and the community of surveyors, the DVW creates and provides innovative formats during the ongoing very uncertain COVID-19 situation. As examples, three selected measures are briefly described.

- Ad hoc working group ‘digitization’: Within this ad hoc working group, experts in the field of digitization created guidelines for the virtual cooperation of DVW’s executive board and within the DVW working groups. The focus was on synchronous and asynchronous collaboration tools for meetings, seminars, and training events considering data privacy, straightforward introduction, and reliability. In addition, important competencies related to virtual cooperation were identified.
- Digitization of DVW events: In the pre-COVID-19-era, most DVW-events (e.g., working group meetings, seminars) were conducted with physical presence of the participants, synergizing in particular the side effect of networking within the community of surveyors. Especially, bringing together young (e.g., students) and senior professionals creates important additional values (e.g., sharpening the picture of the field of work) based on discussions and informal talks. Therefore under COVID-19 circumstances, new virtual formats resp. settings were developed and evaluated.
- Case study ‘COVID-19’s impact on the geo-sector’: In order to obtain a quick and reliable evaluation of the recent COVID-19 situation and enabling the identification of important open questions within the whole branch of surveying, the DVW carried out an ad hoc online survey during March 30th and April 8th 2020 (Hesse et al. 2020).

3. EDUCATION OF YOUNG SURVEYORS

As a result of the COVID-19 pandemic, the German education system experienced a disruptive, externally motivated digitization push (e.g., Skulmowski and Rey 2020). In contrast to well-planned digital change processes (e.g., Bond et al. 2018), this quick reaction – referred to as Emergency Remote Teaching (Hodges et al. 2020) – is one way of dealing with the challenging COVID-19 circumstances, which is currently omnipresent and will have comprehensive impacts on the future. Due to missing societal experiences and missing empirical studies – in general and taking into account important discipline-specific aspects (Becher 1994) – regarding the effect of the COVID-19 pandemic on education, this paper contributes to the scientific discussion with a focus on the education of young surveyors in Germany.

DVW's online survey 'COVID-19's impact on the geo-sector' (Hesse et al. 2020) was based on more than 2.000 participants and provided a comprehensive nationwide overview of the COVID-19 situation in the various surveying-related professional sectors differentiating, for example, between public authority, company and research/teaching. The main focus was on working from home resp. mobile working (e.g., equipment, internet access), satisfaction, productivity decline, and digital tools/methods. Overall, the survey showed that there was a high level of satisfaction with the measures taken. Hesse et al. (2020) concluded that – despite all the recognizable deficits with regard to the availability and application of digital technologies and processes – much had already been achieved.

The proportion of participants from research and teaching in this survey was 9% (approx. 200 participants; approx. 25%: students, approx. 75% lecturers). In addition, dual education (see sect. 3.1) was not taken into account. Therefore, to consolidate the results of the Hesse et al. (2020) survey, to record changes, and to investigate the surveying-related educational system more intensively focusing on professional as well as on higher education, DVW's Working Group 1 (WG1) 'Profession/Education' carried out an additional online survey with a temporal distance of ca. six months in close coordination with the DVW executive board.

DVW's WG1 has 20 members, who 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) based on their individual professional background, knowledge, and attitudes. In this process, WG1 benefits from the diverse professional perspectives of its members, representing public service, private sector, and education.

Before presenting the characteristics (sect. 3.2) and discussing the education-related findings (sect. 3.3) of the WG1-survey (Dutell et al. 2021), in section 3.1 the German education system is shortly described.

3.1 German education system

The education system in Germany has five levels, called primary, lower secondary, upper secondary, tertiary and quaternary (KMK 2019). The elementary school (primary level) and the lower secondary level (e.g., secondary school) as well as continuing adult education (quaternary level) are not in the focus of this paper.

Due to the cultural sovereignty of the federal states in Germany, parts of the education system can be designed and named differently. However, the education system follows a basic framework that is valid nationwide (KMK 2021).

After graduating at a school of lower secondary education level, young surveyors can choose an individual career pathway based on either ...

- ... dual education (upper secondary education level) combining apprenticeships in a company and specific education at a vocational school or
- ... higher education (tertiary education level) at e.g., universities resp. universities of applied sciences.

Both career pathways enable them to enter to the job market. In addition, after graduating at a tertiary education institution, young surveyors are allowed to apply for the individual professional development 'legal traineeship for geo-spatial authoritative positions', which qualifies them for a higher civil service at public authorities.

While the higher education career pathway is very comparable to the world-wide well-known concept of Bachelor resp. Master study programs at universities (of applied sciences), the German dual education system – also known as vocational education and training system resp. dual training system – is shortly described as a special professional option in Germany. The German dual education system (BMBF 2017) combines the acquisition of theory and its application embedded in a real-life work environment (BMBF 2021). The main characteristic is the cooperation between mainly small and medium sized companies and publicly funded vocational schools. Dual education usually lasts two to three-and-a-half years. During the COVID-19 pandemic, training companies also had to face existential challenges (e.g., weak order situation, slowdown of governmental processes) in the first lockdown (Deutschland.de 2021), which affected the training situation in companies and therefore dual education. Within a comprehensive study carried out by the German Ifo Institute, Brandt (2020) quantifies the affecting rate regarding the qualification of apprentices – leading to gaps in knowledge acquisition – to almost 75%.

3.2 Scope of online survey

The main goal of the survey was to obtain a comprehensive picture of digital competency acquisition during the COVID-19 pandemic. In order to generate representative data of the various actors in the education of young surveyors, the four groups students, lecturers, apprentices – including participants of the individual professional development ‘legal traineeship for geo-spatial authoritative positions’ – and training supervisors were formed.

The 23 (maximum number) questions of the anonymous survey were designed in such a way that the complementary perspectives of apprentices and training supervisors as well as students and lecturers could be taken into account. For the two groups, dual and higher education, thematically similar questions were integrated in order to enable meaningful comparisons. At the same time, it was ensured that the questions were motivating, since all questions were addressed specifically to each group. The design of the survey also allowed for individual progression depending on given answers; for example, if an participating apprentice was able to continue training in a classroom setting in compliance with the recommendations given by the Robert Koch Institute (<https://www.rki.de/EN>), questions related to the design of the workplace in the home office were omitted.

After the questionnaire development phase (June–August 2020), the survey was implemented within two weeks using LimeSurvey (www.limesurvey.org/de). The survey was activated on 1st October 2020 and was widely announced by means of various relevant mailing lists, newsletters, websites, and social media channels of the DVW and other professional resp. student’s associations. By the end of the survey on 12th November 2020, a total of 1,663 persons did contribute. For the detailed analysis, the responses of 227 participants had to be skipped (e.g., cancellation of survey).

In the beginning of the survey, the characteristics of the participants were acquired. Most of the participants (99.7%) live in Germany. Very few participants joined from Europe and Asia. The centre of life of the participants is almost evenly distributed (large cities: 37%, medium- or small-sized centers: 31%, rural regions: 32%). About one third of the participants are female, while two thirds are male. More than half of the participants are 26 years and younger, while 1% of the participants are older than 67 years; detailed information is shown in Fig. 1.

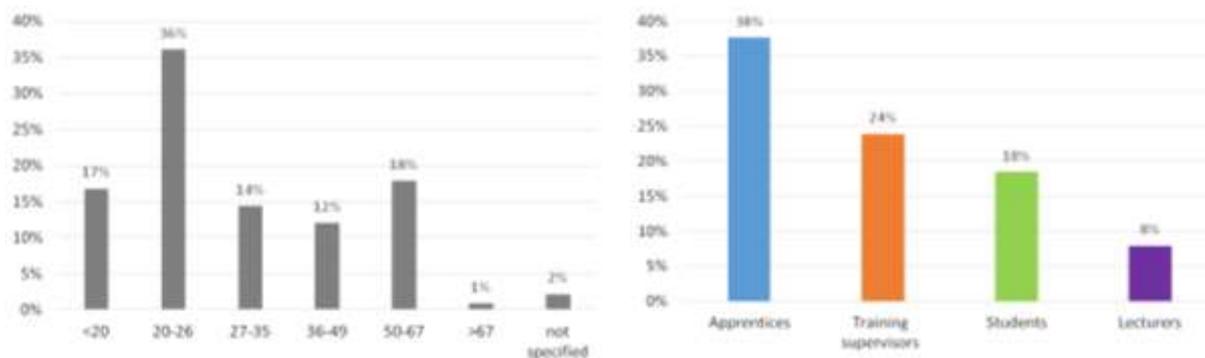


Figure 1: Characteristic of the participants; Left: Age; Right: Role in the education system regarding dual education including individual professional development ‘legal traineeship for geo-spatial authoritative positions (apprentices resp. training supervisors) and higher education (students resp. lecturers)

When analyzing the results of the survey, at first the representativeness of the responses has to be verified. Therefore in the following, the numbers of participants of the groups apprentices (541), training supervisors (343), students (265), and lecturers (114) – see Fig. 1 for the percentage distribution – are compared to the corresponding total numbers of the surveying-related education system. This is not an easy task, especially due to federal states sovereignties and partly missing officially published numbers.

Within this survey, the data assigned to the German dual education system comprise the classical dual education and the individual professional development ‘legal traineeship for geo-spatial authoritative positions’ (see sect. 3.1):

- **Apprentices:** The agencies responsible for dual education in geoinformation technology in the federal states record the yearly numbers of dual education contracts (e.g., 2017: 948; 2018: 1,017; 2019: 1,110). With respect to the three year duration of the dual education and taking into account the yearly numbers of participants of the individual professional development ‘legal traineeship for geo-spatial authoritative positions’, more than 12% of all trainees contributed to the survey.
- **Training supervisors:** With 343 participants, the training supervisors represent the second largest group of participants of this survey, comprising the trainers responsible for the classical dual education as well as the trainers responsible for the individual professional development ‘legal traineeship for geo-spatial authoritative positions’. Based on the nationwide numbers of vocational school locations (27) and surveying-related trainers per vocational school (2), the number of participation of trainers at vocational schools (13) is used to calculate a participating rate of over 20% for the group of training supervisors.

Within this analysis of the COVID-19 impact on the German higher education system, a classification into students and lecturers is used:

- **Students:** The Federal Statistical Office publishes information on the number of students in surveying-related study programs each winter semester (Federal Statistical Office 2021). From 2016 to 2020, approx. 6,500 students were enrolled in surveying-related degree programs in Germany on yearly average. 265 students participated in the present survey, which corresponds to a quota of approx. 4%.

- **Lecturers:** With 114 participants (8%) this group represents the smallest group of the online survey. Currently, surveying-related study programs are provided at ten (15) universities (universities of applied sciences) in Germany. Statistically, 6-7 (approx. 3) lecturers participated per university (university of applied sciences) location. Since an exact number of lecturers is not available, exemplarily information was collected for selected locations (e.g., Karlsruhe Institute of Technology: 37 lecturers, university participating rate: approx. 17%; Bochum University of applied sciences: 34 lecturers, participating rate for universities of applied sciences: approx. 9%).

While in section 3.3 the most important findings of the survey are presented, Tab. 1 gives an overview of the aspects, which were taken into account in the survey. Tab. 1 clearly depicts, that there are aspects which are under identical focus for dual and higher education, but there are also aspects, which are only treated in one of the educational sectors.

Tab 1: Scope of the survey; left column: aspects, treated in the survey; middle (right) column: specific focus of the aspect with respect to dual (higher) education; underlined aspects: not treated in the survey for both education systems

Aspect of the survey	Focus regarding	
	dual education	higher education
Training facility	<u>Number of employees</u>	
Learning-teaching system	Ratio online/classroom teaching; communication; completeness of topics	Ratio online/classroom teaching; communication; <u>teaching/learning formats</u> ; <u>online interaction</u> ; completeness of topics
Switch to online teaching	Pace	Pace; <u>support offers</u>
Working at home	Potential for improvement	Potential for improvement
Individual perception	Overall satisfaction; expected disadvantages	Overall satisfaction; expected disadvantages; <u>most surprising event</u>
Involvement in digital change process		<u>Feedback to university</u>
Exams	Modifications	Modifications
Future of teaching/learning	Proportion of online settings	Proportion of online settings

3.3 Findings of online survey

The findings of the recent online survey (Dutell et al. 2021) show, as depicted in Fig. 2, that most of the higher education took place in home office, while most of the vocational training was carried out further on in the training centers resp. at the companies. About one-third of each group indicated that a hybrid setting – online in combination with classroom learning/training – was applied. The switch to online teaching/learning was implemented quickly in both forms of education (apprentices: 65% after two weeks; training supervisors: 59% after 1 month; students: 86% within one month; lecturers: 74% after two weeks).

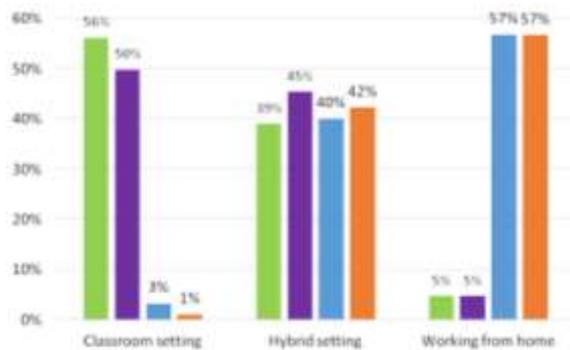


Figure 2: Concept of competency acquisition during the COVID-19 pandemic; responses of apprentices (green), training supervisors (purple), students (blue), and lecturers (orange).

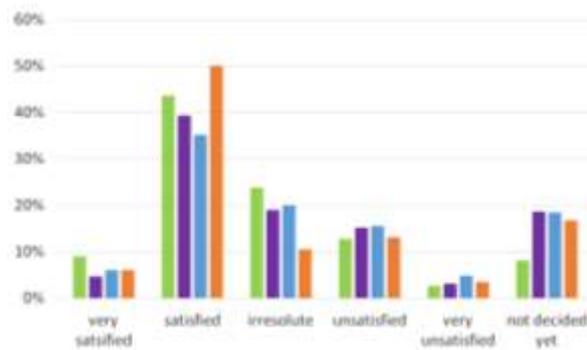


Figure 3: Satisfaction rates regarding measures taken to adapt the effects of the COVID-19 pandemic on the education system; perceptions of apprentices (green), training supervisors (purple), students (blue), and lecturers (orange).

For the educational exchange between apprentices and training supervisors resp. students and lecturers online and video conferencing tools as well as e-mail were used. Telephone conferences were used much more frequently within the dual education system (approx. 70%) than among students and lecturers (approx. 2%), while the use of cloud services was more often mentioned by representatives of the higher education system. In the fewest cases, there was no exchange at all (dual education: 3%; higher education: 0.2%).

When analyzing the impact of the COVID-19 pandemic, the perceived quality of the working place at home has to be evaluated with a special focus on potential of improvement, see Fig. 3 for percentage values. In addition to the comparison of the perceptions regarding apprentices and students, the responses of lecturers are included in Fig. 3 in order to provide a complementary perspective for the higher education system. Most participants particularly wished for a better separation between study/work and private life (Fig. 3, aspect 8). The majority of the dual education participants asked for better access to training-relevant data files resp. file systems (Fig. 3, aspect 5). In contrast, access-related problems were rarely observed from participants of the higher education sector. Here, the home office situation of lecturers is significantly better for all questioned aspects, compared to students' conditions. According to the group of participating lecturers, the second highest percentage value (28%), shows a remarkable full satisfaction with the home office situation (Fig. 3, aspect 11).

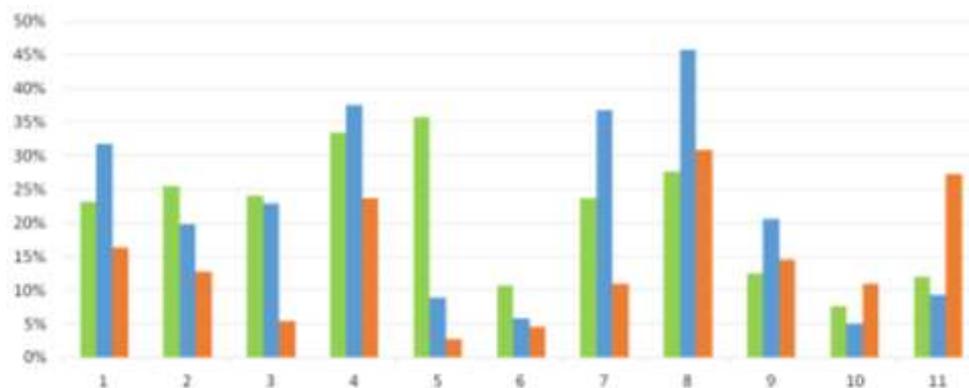


Figure 3: Potential of improvement of working place at home; multiple choice option; 1: Poor internet connection, 2: Missing printer, 3: Missing software, 4: Too small screen / Too few screens, 5: No access to study relevant data / file systems, 6: Insufficient data protection, 7: Additional software has to be installed on private computer, 8: Insufficient separation between life and work, 9: Expected late health effects, 10: Other, 11: None; perceptions of apprentices (green), students (blue), and lecturers (orange).

The survey on cancelled resp. postponed training elements provided comparable results for both forms of surveying-related education, where only 10% of the courses had to be cancelled. While very large parts of the training are proceeding according to the dual education plan – 2% of the participating apprentices were less than 50% in line with the regular education plan – there is more catching up to do within the higher education system (39% of the participating students were less than 50% in line with the regular education plan).

The conduction of exams was also affected by the COVID-19 pandemic. While within the dual education sector, most learning objective monitoring was carried out in the regular setting and some had to be postponed, the situation at universities behaves more variable. Most noticeable was the change for oral exams from presence to online settings. Here it is assumed, that lecturers at universities have more impact on the design of exams compared to the dual education sector.

Analyzing the perception of considered disadvantages compared to previous years, within the higher education sector approx. two thirds of the participants (students: 63%; lecturers: 66%) expect tolerable or no students' disadvantages. Comparable results were found in the dual education sector, where 72% of the participating apprentices and training supervisors expect tolerable or no disadvantages.

For both types of education under research, identical as well as different problems were detected. As outstanding conclusion, similar results were found for the over-all satisfaction (approx. 50%) with the education of young surveyors during the COVID-19 pandemic (see Fig. 4).

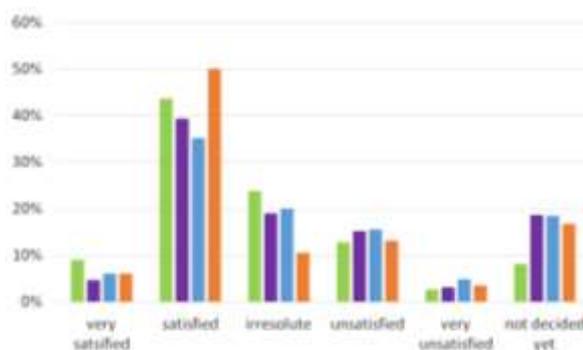


Figure 4: Satisfaction rates regarding measures taken to adapt the effects of the COVID-19 pandemic on the education system; perceptions of apprentices (green), training supervisors (purple), students (blue), and lecturers (orange).

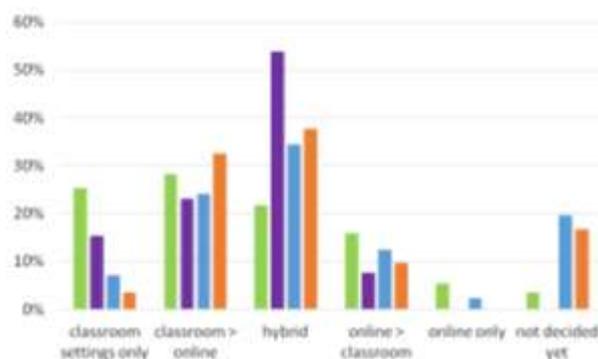


Figure 5: Requested portions of online teaching in post-COVID-19-era in vocational training resp. at university; responses of apprentices (green), training supervisors (purple), students (blue), and lecturers (orange).

After analyzing the present status of the COVID-19 pandemic during March and November 2020 in this survey – exploiting the experiences and perceptions of the participants – a final question was dealing with future concepts – including the post-COVID-19-era – for compe-

tency acquisition (see Fig. 5). As expected based on the high satisfaction level (Fig. 4), the participants recommend that the future of the education of young surveyors should include a significantly high level of online elements.

4. CONCLUSION AND NEXT STEPS

The findings of DVW's initial online survey of Hesse et al. (2020) for the field 'research/teaching' correspond highly to the results of the higher education sector presented in this paper. Therefore, a stable situation within the higher education sector during the first seven months of the COVID-19 pandemic can be expected. In addition, this survey generated valuable insights into the dual education sector.

In conclusion, it can also be stated that teaching and learning under emergency conditions during the COVID 19 pandemic enabled comprehensive experiences to be gained – also with regard to digital feasibility – in digital teaching/learning formats. In particular this will enable the teaching/learning system to be further developed individually and within organizations with a focus on digitality in the future. In this context, the agile solution orientation and the predominantly positive individual experiences will contribute to a sustainable design of the digital transformation.

In particular, many highly dynamic and rapid learning as well as digital transformation processes are currently taking place within organizations (e.g., universities, companies, professional organizations) triggered by the COVID-19 pandemic. Therefore, it can be assumed, that modern and flexible information societies like Germany are currently extensively experiencing a sustainable paradigm shift towards digitality. This also directly affects the professional field of Geodesy, Geoinformation, and Land management represented by DVW. The competent, flexible, and effective support as well as the active further development of this process is therefore a central concern of the DVW, since these processes will feed back into the education of young surveyors resp. individual further development of surveyors of the working world.

DVW's WG1 has planned to further monitor the impact of COVID-19 on the education of young surveyors. As next steps the various individual free text responses of the online survey described here will be exploited regarding the question 'What has surprised you most in the context of COVID-19 related to teaching and learning?'. In addition, it could be observed that the amount of responses within the higher education system was low compared to those from the dual education sector. Therefore, interview and community-based formats are planned to be carried out to exploit this potential for improvement.

In general, the international study 'Questionnaire on Surveying Students Learning and Studying Approaches' of the impact of COVID-19 on the education of young surveyors, coordinated by FIG's Commission 2 'Professional Education' and FIG's Young Surveyor Network with respect to COVID-19-related findings of other disciplines have a great potential to generate a valuable basis for international collaborations in education, documentations of good educational practice, and more robust educational systems.

ACKNOWLEDGEMENT

The authors of this paper would like to thank all participants of the online survey, Ina Loth (DVW office) for her administrative help during the set-up of the online survey, and DVW's WG1 members Claudia Zmyslony, Jennifer Runge, and Erik Jensen for a close and trusting cooperation during the development, the implementation, and the analysis of the online survey.

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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. As senior scientist at KIT's (Karlsruhe Institute of Technology) Geodetic Institute he is responsible for education and research in the field of Earth observation. In addition, he is responsible for the further development of the teaching and learning system of the geodetic study programs and within KIT's Department of Civil Engineering, Geo and Environmental Sciences. He is active member of Working Group 1 'Profession/Education', German Association of Surveying (DVW).

Dipl.-Ing. Jerome Dutell received his University Degree in Geodesy based on study at Technical University of Darmstadt. He is head of department at the district government Detmold and training manager for individual professional development 'legal traineeship for geospatial authoritative positions'. In addition, he is audit committee chairman for dual education in Geodesy at the government district Detmold and long-term active member of DVW's 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.

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On the Status of Geodetic Education in Germany during the COVID-19 Pandemic (11071)
Michael Mayer, Jerome Dutell and Monika Przybilla (Germany)

FIG e-Working Week 2021
Smart Surveyors for Land and Water Management - Challenges in a New Reality
Virtually in the Netherlands, 21–25 June 2021