

## Are medical students equipped for digital studies? Have their hopes and fears been confirmed during Covid-19? What should we consider in the future?

Stephanie Herbstreit<sup>a</sup>, Margarita Gestmann<sup>b</sup>, Cynthia Szalai<sup>c</sup> and Anke Diehl<sup>d</sup>

<sup>a</sup>Department of Trauma-, Hand- and Reconstructive Surgery of the University Hospital Essen, University of Duisburg-Essen, Essen, Germany; <sup>b</sup>Dean of Studies Office Faculty of Medicine, University of Duisburg-Essen, Essen, Germany; <sup>c</sup>Department of Anesthesiology and Intensive Care Medicine and SkillsLaboratory University Hospital Essen, University of Duisburg-Essen, Essen, Germany; <sup>d</sup>Department for Digital Transformation, University Hospital Essen, University of Duisburg-Essen, Essen, Germany

### ABSTRACT

Digitisation in the education of future doctors was still in its infancy before the Covid pandemic. For the successful implementation of digital teaching, students need the technical equipment and the necessary skills to use it in a meaningful way. Furthermore, it requires a willingness to adapt the learning environment and to take responsibility for self-directed learning. At the beginning of 2020, faculties were forced to convert all teaching to digital formats. Initial research shows that students prefer face-to-face teaching. To determine whether medical students were prepared for digital studies and what should be considered for the future, we analysed surveys at the beginning of online studies and after two Corona semesters at a medical faculty. We were able to show that although our students had good technology equipment, they had a rather negative attitude towards online teaching for various reasons and developed negative emotions. Deficits in design of educational material, and personal learning habits raised concern. A lack of guidance and a lack of interaction with fellow students contributed to this. Adjustments in these areas will be necessary in the future to provide students with positive access to digital studies and thus increase learning success.

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## Introduction

Digitisation of teaching and learning formats in education and training in medicine was already discussed before the Corona pandemic. Mostly, it was about the establishment of digitally supported didactic formats such as blended learning, the use of digital media and communication tools as well as digital examination as part of the medical curriculum [1]. Many German universities and continuing education formats previously used only a small part of the possibilities offered by new digital technology for studying and teaching [2–4]. Medical studies are mostly characterised by traditional forms of teaching such as lectures and seminars. In addition, there was and still is teaching of practical skills at the patient's bedside and in training centres. At the beginning of the Corona pandemic, the aim was to ensure that the training of doctors was as continuous as possible in order to guarantee the next generation of doctors without any gaps. The universities were forced to develop and implement online lectures, teaching videos and other digital teaching formats in a very short time, with teaching of practical skills almost coming to a standstill. The ordinance on the (temporary) change of the

national training curriculum (“Approbationsordnung”) of 30 March 2020, enabled the redesign of teaching events based on digital media ([https://www.bundesgesundheitsministerium.de/fileadmin/Dateien/3\\_Downloads/Gesetze\\_und\\_Verordnungen/GuV/A/VO\\_Abweichung\\_von\\_AEA\\_pprO.pdf](https://www.bundesgesundheitsministerium.de/fileadmin/Dateien/3_Downloads/Gesetze_und_Verordnungen/GuV/A/VO_Abweichung_von_AEA_pprO.pdf), accessed on 12 September 2021).

Learning management platforms such as Moodle® or Ilias® were set up or expanded to make online teaching available. Video portals have been created or purchased from third-party providers such as Zoom®. Various teaching and learning scenarios range from uploading PDF documents, audio-video files of teaching materials, online instruction for self-directed learning and assessments, to video conferencing as part of classroom events.

An essential requirement for the digitisation of teaching and learning is the availability and functionality of the necessary hardware and software, as well as a stable internet. This also includes being able to use all types of technologies appropriately. As part of the education campaign for the German Digital Knowledge Society, equal access to education was

**CONTACT** Stephanie Herbstreit  [stephanie.herbstreit@uk-essen.de](mailto:stephanie.herbstreit@uk-essen.de)  Hand- and Reconstructive Surgery of the University Hospital Essen, University of Duisburg-Essen, Essen, Hufelandstr. 55, 45147, Germany

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called for, in addition to the acquisition of skills for the future digitally shaped world of life and work [5].

In addition to these technical requirements, the question of whether students have been ready to adapt their learning environment to online learning, e.g. to structure and organise their own learning activities, is up for discussion. It is known that students should be mentally, emotionally and physically ready for effective online learning [6] and that the individual student can be ready for online learning through access and competence in technological tools, with the ability to use social networks and take learning responsibility [7]. A positive or negative attitude towards online learning also has a significant impact on the online learning success [8].

Initial research during the Corona pandemic indicates that students nevertheless tend to still prefer face-to-face teaching in the future [9] and that they need structured guidance despite motivation and good technical equipment [10]. Furthermore, negative psychological effects of distance learning could already be shown during the Corona pandemic [11].

In our study, we had the opportunity to survey students of the Medical Faculty at the University of Duisburg-Essen shortly after the sudden transition to online teaching (survey I) and after one year of online teaching due to the pandemic (survey II).

The aim was to qualitatively analyse whether medical students have the necessary personal and technical requirements as well as competencies to participate in online teaching. What opportunities or risks did medical students see for online teaching and were their assumptions confirmed? Were they prepared for online teaching and what emotional effects did they experience with regard to online learning?

## Methods

The target group included the students of the Faculty of Medicine at the University of Duisburg-Essen (UDE) enrolled in the summer semester 2020 (SoSe20) in our survey I and enrolled at the end of the winter semester 2020/21 (WiSe20/21) in survey II. The Center for Higher Education and Quality Development (ZHQE) of the UDE developed a student survey on behalf of the university management at the beginning of April 2020. This was done in consultation with representatives of the students at the Faculty of Medicine via the evaluation portal Evasys. Due to the central development, there was no influence on the questionnaire of the survey. The link to the survey was sent by email with an invitation text. The students were informed about the voluntary nature of

the survey in the period from April 20th to May 10th, 2020 and the purpose of the survey. The students agreed within the questionnaire that the personal data, according to the listed information would be processed. After completion of two semesters within the first year under Corona conditions and mostly online teaching, the cohort was re-surveyed as part of the nationwide Progress Test Medicine (PTM) from April 12th-26<sup>th</sup>, 2021; online via the evaluation portal EvaLuna. Participation in the test and the accompanying survey was also voluntary and subject to consent. The total number of students contacted at both times was 1346 students each. In survey I, 426 students responded to the questionnaires, corresponding to a response rate of 32.8%. In survey II, 412 students answered the open-ended questions, corresponding to a response rate of 30.6%.

At the beginning of the pandemic, survey I aimed at the students' media technology equipment, software & media competence and the opportunities of communication and collaboration regarding distance learning. A selection of the results for the research question has been used in this study. For the questions about equipment, multiple responses were possible. Regarding the questions on functioning and readiness, a Likert scale (1 = "completely agree" to 5 = "completely disagree") was used. In the questions about communication and collaboration, students were asked to rank the selected items. The results of the survey were provided by aggregation. Percentages are presented for multiple answers and for yes/no answers, mean values and standard deviation for Likert scale values. Ranking lists were created in the case of information on an order.

Furthermore, there was the possibility to give free text answers to "*reasons for obstacles in participating in online teaching*", as well as "*whether they expect problems from a technical point of view or need support*". In addition, they were asked for "*wishes and comments on communication & collaboration*" and "*what opportunities and risks they see for online teaching*", plus "*what could be done on the side of the teaching staff*".

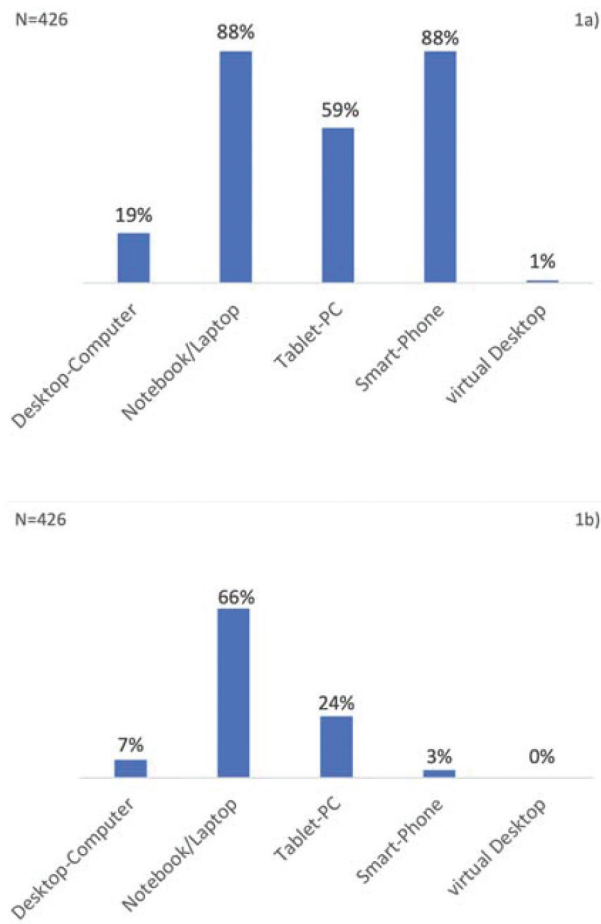
After completion of the first year under Corona conditions, students were asked to provide free-text answers to the open-ended questions about "*how they have adapted their learning behavior*", "*what positive and negative changes they have experienced in their learning environment*", and "*whether overall and if yes or no, how their emotional state has changed in relation to their studies*" in survey II. The analysis of the free-text answers of survey I and II was done using content-based structured qualitative analysis and was category-based [12] with the help of MAXQDA™ by VERBI for computer-assisted qualitative data and text analysis.

Categorisation was carried out by context of meaning, valuations, and relevance of the statements. For improved presentation, the responses in the categories were quantified and presented as numbers or percentages.

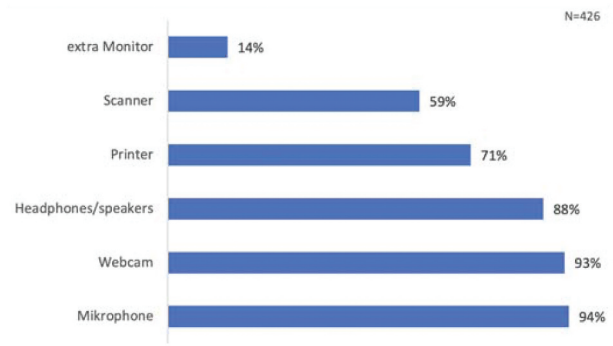
### Results

Within the closed questions of survey I, the students indicated from a pre-selection that they have various technical devices at their disposal. For learning, they mainly used a notebook/laptop and less often, tablet PCs (Figure 1a and 1b). Approximately 90% of students reported having good technical equipment for participating for example in video conferences (Figure 2). 9 out of 10 students had a flat rate via a router from a telecommunications provider at the time of the survey (Figure 3).

On a Likert scale of 1–5 (1 = “strongly agree” to 5 = “strongly disagree”), students indicated that they believed their media technology equipment was



**Figure 1.** (a) Which device(s) do you have available for online learning? b: Which of your devices did you use most often? (multiple answers possible, percentage, N = 426).

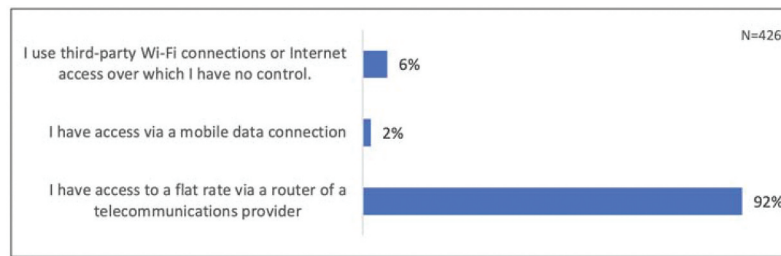


**Figure 2.** Which additional device(s) do you have available to support your study-related work (e.g. for participation in digital teaching formats or self-study)? (Multiple answers possible, percentage, N = 426).

sufficient to participate in internet-based videoconferencing and to perform study-related activities. They believed that their bandwidth, or data volume, was sufficient for the demands of online teaching (Table 1). Regarding the question about their software and media competence, the students stated that they were basically familiar with the use of learning management systems and were also more willing to deal with them in greater depth (Table 1). Furthermore, the students stated that they were already well or very well equipped with standard software programs and, regarding communication programs, 3 out of 4 students stated that they were familiar with them, too (Figure 4). Students were more likely to fear difficulties (58.2%) in setting up the required software for the online semester, that these in particular may be costly and that they are not familiar with the technical setup (Figure 5).

Almost 90% of the students indicated that they would like to have course-related consultation with the lecturers, preferring to do so in small groups rather than alone or in pairs. As a means of communication, they tended to prefer emails with lecturers, and messaging services and social media with their fellow students (Figure 6).

In response to the open-ended question of what might hinder students from completing course-related activities from a technical perspective and in what they need support, a total of 277 comments were analysed and assigned to five categories. Specifically, students worried about difficulties with their data connections, such as weak or slow internet, files too large for their network, and difficulties with video conferencing. They worried that their hardware was outdated, or tablet PCs not suitable, software not sufficient for learning with



**Figure 3.** What is your primary mode of access to the internet for your study-related work/learning? (single choice, percentage, N = 426).

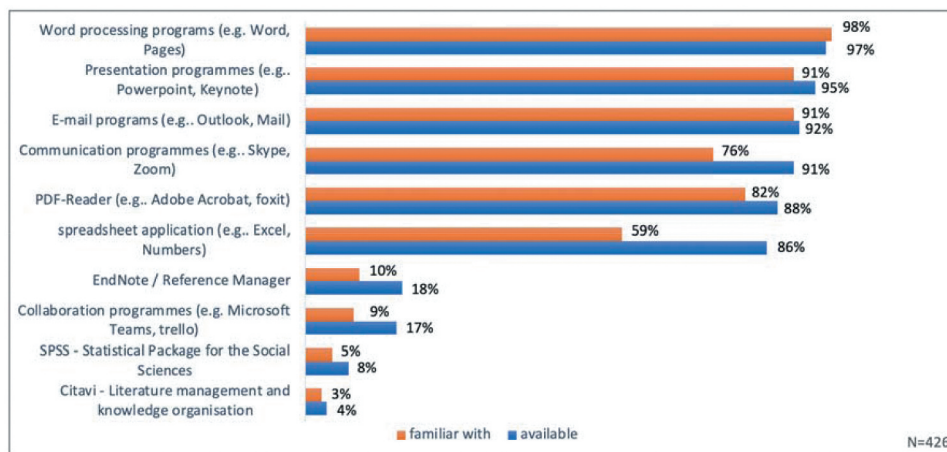
**Table 1.** Likert scale scores of students' assessment of their media technology equipment and handling of learning management systems as mean value (MV) and standard deviation (STD), (Likert scale: 1 = "agree completely" to 5 = "disagree completely", N = 426).

Is the media technology equipment sufficient? N = 426	M	STD
I assume that I can participate in Internet-based voice/video conferences with the media technology equipment available to me.	1.66	0.17
Overall, I assume that the bandwidth or data volume available to me is sufficient to carry out study-related activities.	2.11	0.19
With the devices available to me, I assume that I can do the study-related activities, online as well as offline, from a technical point of view.	1.86	0.23
<b>Handling of learning management systems N = 426</b>		
I am basically familiar with the use of learning management systems.	1.98	0.23
I am ready to deal with learning management systems in more depth.	1.91	0.096

videos, and that organising video conferences would be difficult and confusing. Technical problems due to lack of experience were also mentioned (Figure 7). A total of 84 comments related to desires for communication and collaboration within courses were analysed. More than 50% of the answers referred to provision of additional material like slides and lecture notes. In addition

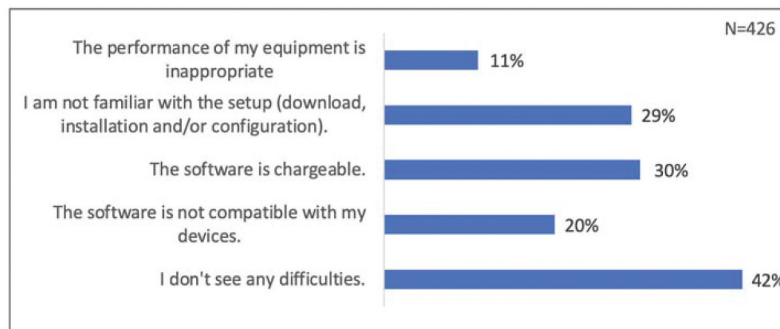
to the request for exam information, percentage of those disliking virtual meetings slightly ("no Live-Communication") exceeded those asking for more meetings of this type ("Live-Communication") (Figure 8).

Students were further asked to provide free text comments on their expectation regarding opportunities or risks of online courses. A total of 671 comments were made on this question. Of these, 413 addressed risks and 258 opportunities (Figure 9). Risks could be grouped into 6 categories: Concerns about teaching, learning content and methods were expressed most frequently, especially that shorter units of education with less practical skills and less sustainability of knowledge will be offered. In the category of self-organisation of learning, the most frequently mentioned concern was a potential lack of self-discipline. In the category of communication, there were mainly concerns about the lack of exchange with fellow students and, to a lesser extent, with lecturers. Concerns also existed regarding a confusing and incomplete organisation and structure of courses. Concerns about technical problems were expressed less frequently (Figure 10).

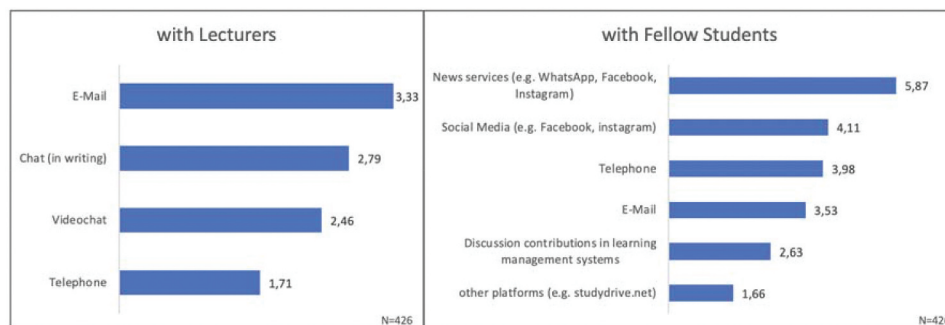


**Figure 4.** Which of the following software had been set up on your device(s), and which have you been familiar with already prior to the switch to e-learning? (multiple answers possible, percentage, N = 426).

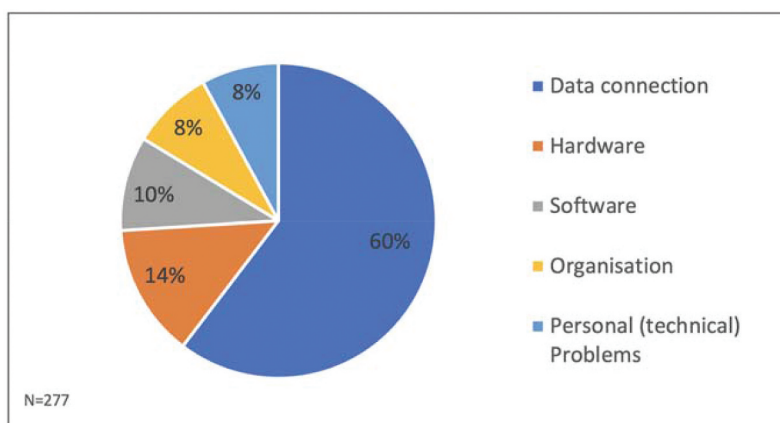




**Figure 5.** Please indicate the most urgent problem related to the software needed for your e-learning activities (single choice, percentage, N = 426).



**Figure 6.** Which communication channels do you prefer to stay in contact? Ranking of preferred course-related communication channels with lecturers and with fellow students (The frequency of the highest ranked was put in order, N = 426).

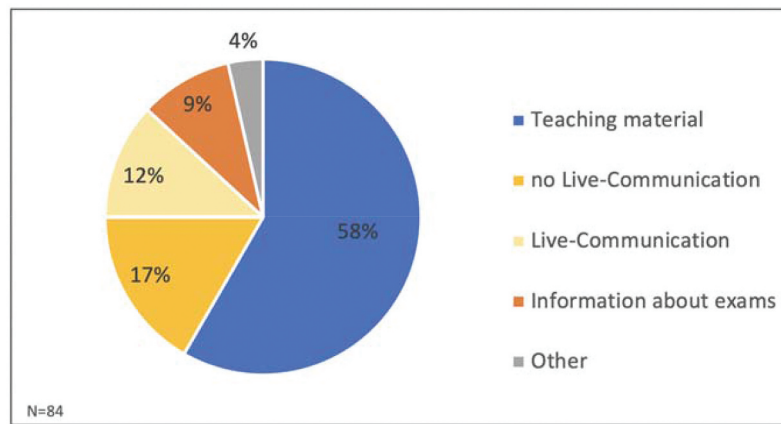


**Figure 7.** Pie chart of the answers related to the question: Which technical issues might impair your progress and/or what support do you need? (percent, N = 277).

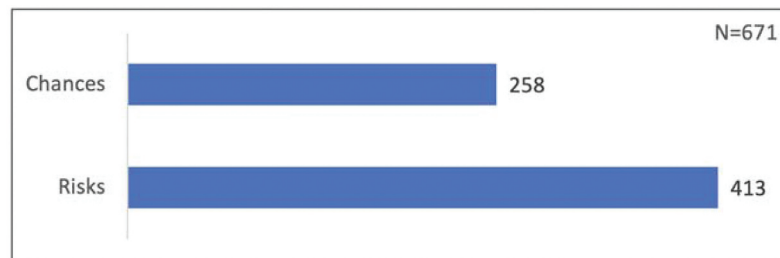
5 categories could be identified regarding future opportunities for e-learning. Advantages of more flexible and individual learning were clearly seen most frequently, with possibly higher effectiveness of learning and more intensive learning. In the self-organisation category, the elimination of travel was particularly cited as a time gain. Occasionally,

opportunities for technological progress and multimedia use in teaching were mentioned. Few comments mentioned easier communication with lecturers and that the risk of infection can be reduced during the Covid-19 pandemic (Figure 11).

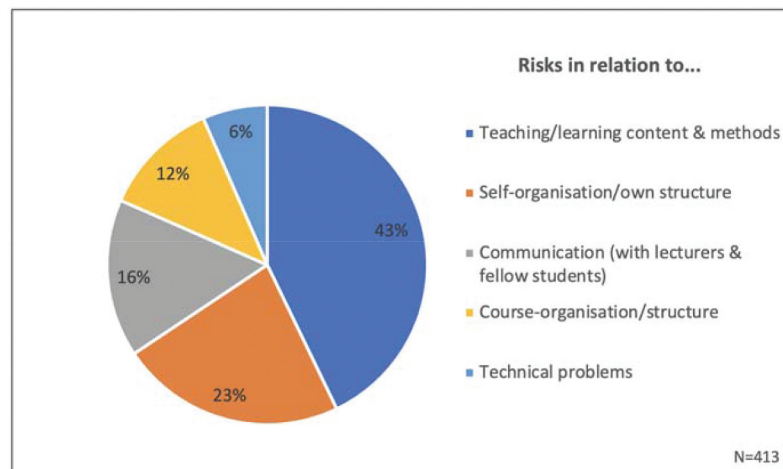
302 statements have been received on what might be improved in the provision of education which could be



**Figure 8.** Pie chart of the answers related to further wishes and comments on course-related communication and collaboration (Percent, N = 84).



**Figure 9.** What opportunities or risks do you see, if courses will only be offered online? Number of risks and opportunities expressed (N = 671).



**Figure 10.** Pie chart of risk categories as perceived, if courses would only be offered online (Percent, N = 413).

grouped in 4 categories. In the category of organisation of courses, students requested clear structures. In the content category, students requested clear and structured learning content and objectives, and knowledge assessment (e.g. mock exams or quizzes). In the methodology category, some wanted more live streams, what others (a smaller group) did not prefer. With regard to

communication, students particularly requested contact persons should be nominated (Figure 12).

Based on the experience after one year of Covid pandemic survey II analysed and categorised a total of 497 comments in response to the open-ended question of how students adapted their learning behaviours during the pandemic. The adaptations in the most frequently

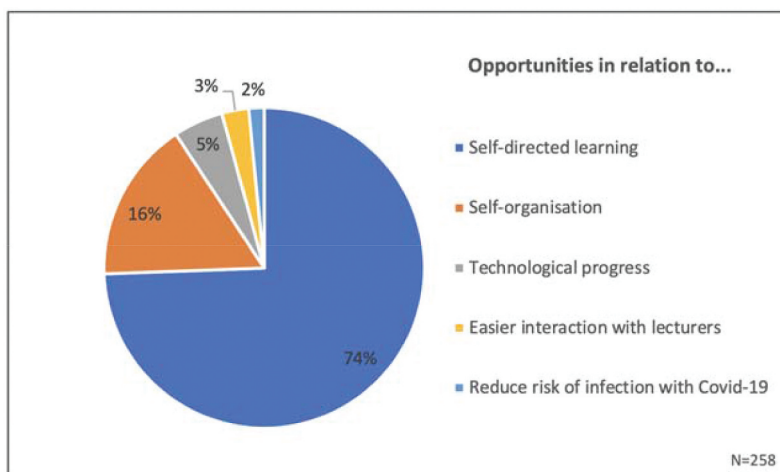


Figure 11. Pie chart of opportunities (by category) as perceived, if courses would only be offered online (Percent, N = 258).

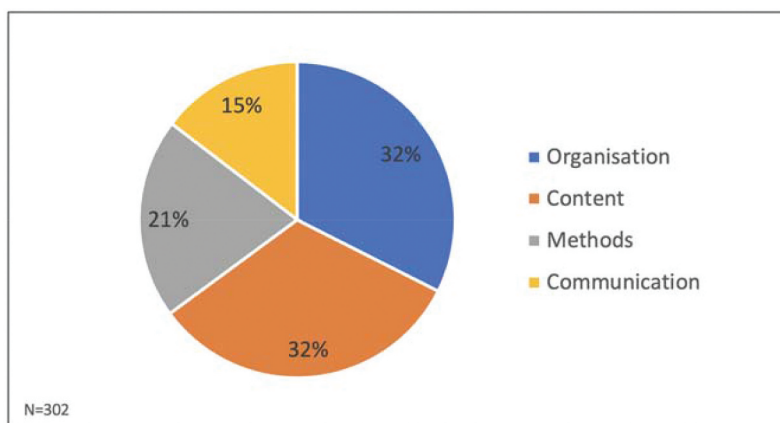


Figure 12. Pie chart of answers related to the areas of concern for which more engagement of teachers has been demanded by the students (Percent, N = 302).

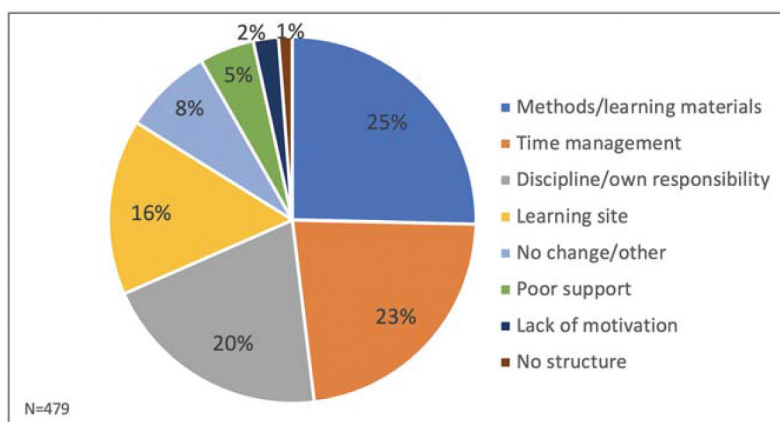


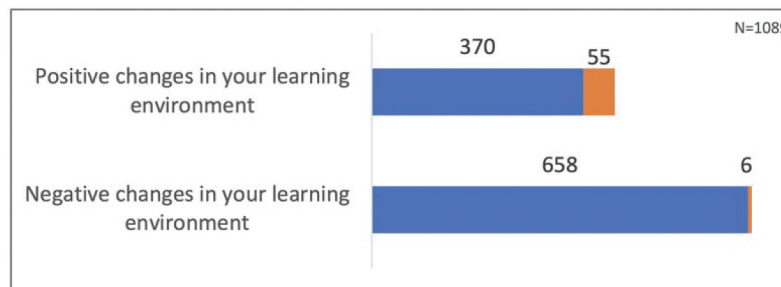
Figure 13. Pie chart of answers on factors supportive or discouraging in adaptation of students' learning behaviour during Covid-19 pandemic (Percent, N = 479).

mentioned categories related to methods and learning materials used, personal time management, and responsibility for learning. Regarding educational material, the offered material but also material from other sources has been used and learning alone increased. Learning groups were attempted online via video chat and learning plans were created. In terms of time management, comments indicated that there was significantly more time available but that structuring one's own schedule remained a challenge. Students reported a sufficiently high level of self-discipline and personal responsibility to maintain their learning activities throughout the semester. Naturally, the place of learning changed, with some students lamenting about lack of support in the structure by the lecturers but also blaming a lack of self-motivation (Figure 13). Overall, in 1089 comments students described more negative than positive changes in the learning environment during the pandemic (Figure 14).

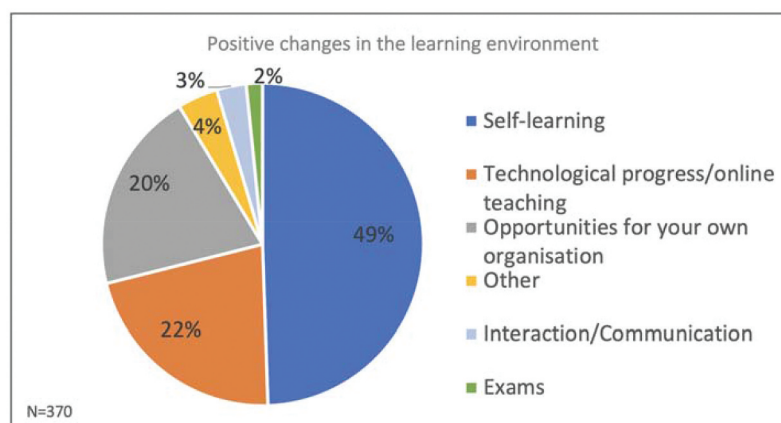
In response to the open-ended question of what was considered to be the most positive change in the learning environment during the Corona semesters, 55 comments indicated that nothing positive had occurred. In

the remaining 370 responses, 6 categories could be identified. With respect to the own learning process, an improved time management of learning was most often rated as positive. Other items rated positive included no need for travel, flexibility in timing of learning activities as well as more opportunities for breaks when learning at home. Positive changes have also been noted for improvement of online teaching, digitisation of learning content, and meaningful use of learning management systems. Few comments regarding interaction and communication related to the elimination of competitive pressure in particular among fellow students. Adaptations of internal faculty exams to the Corona pandemic were rarely welcomed (Figure 15).

658 comments about the open-ended question asking for the most negative changes could be grouped in 6 categories: More than one-third of the comments mentioned loss of personal contacts and fewer exchange with fellow students. Less frequently, but still notably, poor supervision by or only scarce contact to lecturers was also mentioned. Approximately

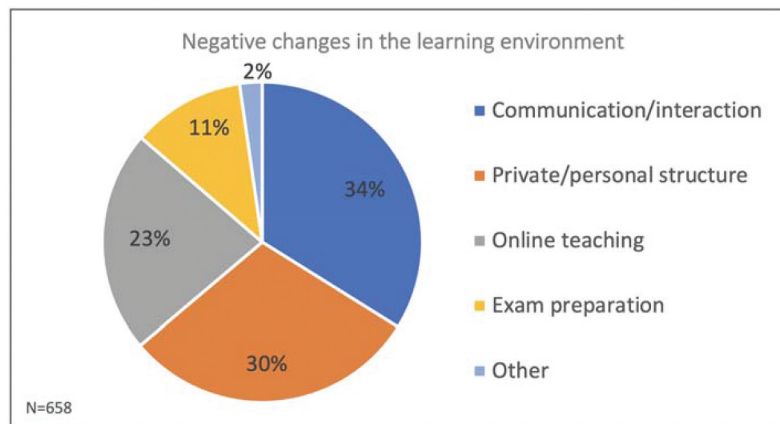


**Figure 14.** Number of Comments to the two questions: What were the most positive changes in your learning environment during the Corona semesters? What were the most negative changes in your learning environment during the Corona semesters? 55 responses to the most positive changes and 6 responses to the most negative responses indicated “no changes” (in Orange) (N = 1089).

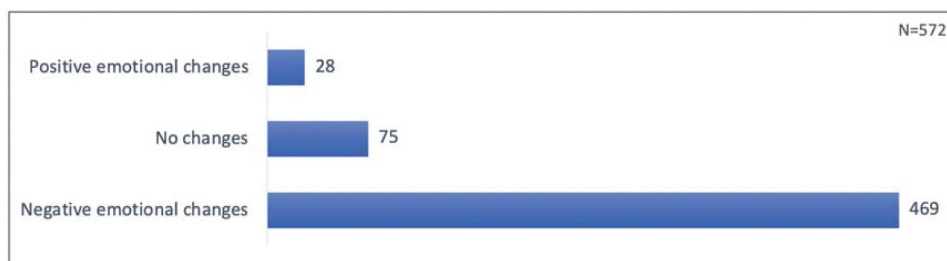


**Figure 15.** Pie chart for answers (by category) to the question: What have been the most positive changes of your learning environment during the Corona semesters? (Percent, N = 370).





**Figure 16.** Pie chart for answers (by category) to the question: What have been the most negative changes in your learning environment during the Corona semesters? (Percent, N = 658).



**Figure 17.** Number of negative vs. positive vs. no changes in emotional state during the two semesters in Covid-19 times (in total N = 572 statements).

another third of comments mentioned difficulties in designing their own learning environment and in time management. Psychological stress and difficulties in finding a “work-life balance” were also mentioned with striking frequency. The inability to improve practical skills was particularly regretted, also with respect to the preparation for future employment. The technical- and content-related quality of some online courses as well as the lack of preparation of some lecturers received criticism and the uncertainty about schedule and specifications of execution were also expressed (see Figure 16).

In response to the question whether and how one’s own emotional state in relation to studying changed during the Corona semesters (SoSe 20 & WiSe 20/21), a total of 572 comments were analysed. More than 80% described negative emotional changes, 13% of the comments mentioned no changes and less than 5% showed positive emotional changes (Figure 17).

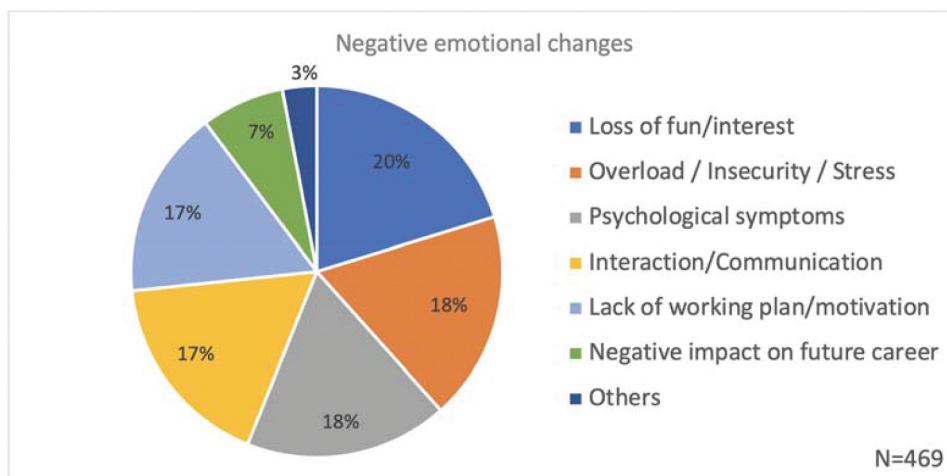
469 responses related to negative emotional changes could be grouped in 7 categories of which 5 showed very similar response rates. A loss of fun and interest was documented with emotional changes ranging from displeasure, anger, or lack of joy up to resignation.

Similarly frequent comments were found in the category of being overwhelmed, referring to stress, lack of breaks, and helplessness. Psychological symptoms comprised melancholy and depression, self-doubt/despair, anxiety, and anger with irritation. Lack of social contacts at the university also led to negative emotions, as did the lack of one’s own working plan and motivation. Less frequently students were afraid of a negative impact of the current learning environment on their future career (Figure 18).

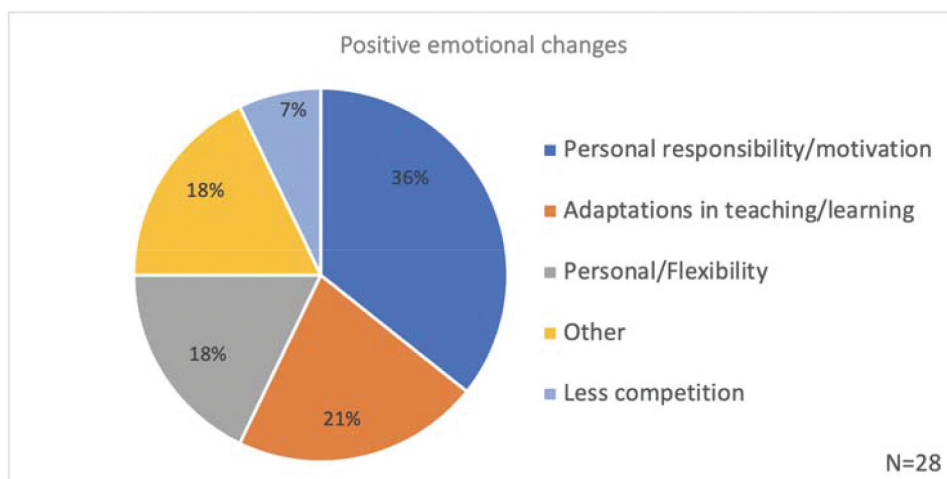
Few answers only (n = 28), falling into 5 categories, have expressed positive emotional changes, including development of personal responsibility for learning, a positive attitude towards high flexibility and development of online teaching, as well as low competitive pressure from fellow students (Figure 19).

## Discussion

Medical education has been facing a significant number of challenges in the beginning of the Corona pandemic. The number one rule was to try by all means to continue with student education. Within 5 weeks, digital structures in teaching had to be substantially



**Figure 18.** Pie chart for answers (by category) related to negative changes during Covid-19 (Percent, N = 469).



**Figure 19.** Pie chart for answers (by category) related to positive changes during Covid-19 (Percent, N = 28).

expanded or even newly created. Many discussions revolved around the technical challenges students might face [13]. It is well known that private use of digital media does not automatically lead to safe use in students' everyday university life, in particular because digital media have not been an integral part of teaching at many universities [2,3].

Our survey in a medical faculty in the federal state of North Rhine-Westphalia (reaching > 30% of the enrolled students in a Corona year) indicated good to very good media technology equipment for participation in online teaching of our students at the beginning of the pandemic. Many online courses were offered as video conferences, and again, over 90% of the students appeared to be well equipped in terms of devices and access to the internet. Nevertheless, it was evident from the free text comments that students were particularly concerned about data connectivity issues or hardware

problems in the context of online teaching. Even if the students were optimistic that their media technology equipment was sufficient to carry out video conferences and study-related activities online, it should be noted that not all students could meet the technical requirements [8]. In the future, these students need to be identified, and assistance should be offered (e.g. providing equipment on loan from the university).

In terms of software and media competencies, our survey confirms the existing discrepancy between equipment and familiarity with required software [3]. More than half of the students feared difficulties in setting up even more software, that the software might be costly, and that they were unfamiliar with the setup. Since there were no comments regarding media technology equipment or how to use it in our second survey after two Corona semesters, it can be assumed that this was no longer of significant relevance to students. Nevertheless,

these points should be considered when selecting the materials provided, e.g. for video presentations. Technical formats compatible with common software systems should definitely be preferred.

Learning management systems (LMS) have already been in use in medical schools prior to the Covid pandemic. They were mainly utilised to provide course-related materials [14] or to communicate with students [15]. However, the use of these systems depends a lot on the quality of the quoted material and proactive introduction by the lecturers [3,14]. Our students were willing to engage with LMS in more depth. In this respect, they had specific ideas about teaching and exam materials but disagreed on the question of synchronous or asynchronous teaching. To better understand the possible challenges or preferences of students this heterogeneity of statements should be further explored in the future.

Although at the beginning of the Corona semesters, one sixth of the comments on possible risks expressed concerns about communication with the lecturers, communication with them was rather requested by email than by face-to-face contact. After two Corona semesters the indicated lack of contact with the lecturers expressed the need for regular structured communication on organisational and content issues [13].

At the start of the pandemic, in depth preparation of students for online teaching was not possible in the short time available [6]. The finding that the number of perceived risks outweighed the potential opportunities suggests that the expectations of online teaching were rather less positive at the beginning, which could have an influence on learning success [8]. In addition to concerns about lack of practice, students expressed concerns about their own learning plan and even more about communication/interaction with instructors. Lack of communication with fellow students was mentioned rather less frequently at the beginning. However, the survey after two Corona semesters clearly showed that students primarily lacked interaction with fellow students. The existence of functioning social networks is, however, a requirement for effective online learning [7]. For the future, therefore, elements involving communication and cooperation should be increasingly incorporated into teaching, so that opportunities for discussion and collaboration are created.

Well-Organised and structured independent learning is a requirement for success in online learning [6,7]. Thus, not surprisingly, one third of the students' comments indicated clear learning deficits after two Corona semesters. In addition to the lack of contact with lecturers, students mentioned deficits in online teaching methods and in exam preparation. It remains

to be clarified whether this was due to content or organisational design of the online teaching. However, it seems necessary to accompany students in their learning in a more structured way.

At the beginning of the pandemic, students hoped for a time advantage and more flexibility for their own learning process. This seems to have been confirmed for a small group of the students who experienced positive changes in their own learning environment. For the larger part, the perceived disadvantages outweighed the potential benefits of online teaching [9].

Negative psychological effects of distance learning during the Corona pandemic have already been demonstrated by others [11]. For example, limited mobility among medical students in Malaysia and students of other disciplines in Spain resulted in anxiety disorders and other psychological symptoms [16,17,18]. Basically, our students tried to adapt their own learning behaviour especially in terms of learning methods and materials, their own learning plan and time schedule and in terms of personal responsibility for learning. This is considered to be a requirement for online learning success [6,7]. However, since our students predominantly reported about negative emotional changes, it can be assumed that the cohort did not succeed in adapting sufficiently to online teaching. Although emotional changes unrelated to the learning environment, such as decreased mobility or lack of other social contacts during lockdown cannot be ruled out. A recent study in engineering students during the Corona pandemic indicates that the quality of online teaching, course adaptation, learning environment, and connection with students and faculty correlate with student emotions [18]. A relation between negative emotions and negative ratings of our students regarding online teaching, as reflected in one quarter of the comments, can therefore be assumed.

The few comments on positive emotional changes suggest that only a few students were able to adapt and take responsibility for their own learning. Since we were not in the position to add or alter certain questions of the questionnaire, we could not evaluate students' basic digital competence, learning conditions at location used for learning, and other factors that may have an impact on successful organisation of self-directed learning and personal responsibility [13]. Nevertheless, the future need for better guidance on self-directed learning has been evident.

Since only students from one faculty have been included in this survey, the sample might not be representative. However, since medical studies in Germany are nationwide regulated (in a licencing regulation

called “Approbationsordnung”) all medical faculties have been facing the same challenges to keep pace with the requirements of the licencing regulation under lockdown conditions. Thus, it might reasonably be assumed that experiences with the change to online learning have been similar in other faculties, too.

It can be concluded from our study, that a regular contact with lecturers, structured content support, and exchange and interaction with fellow students can mitigate possible negative emotions towards online-studying and promote successful online teaching. However, faculty also needs to improve, including to adapt content and design of online-teaching as well as teaching formats, facilitate communication and interaction between teachers and fellow students, and guide students towards fully independent self-directed learning.

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