Dental education during the COVID-19 pandemic in Germany – cross-sectional lecturer-side evaluation for the application of digital teaching concepts [version 2; peer review: 2 approved, 1 approved with reservations]

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Cross-sectional evaluation for the use of digital teaching concepts during pandemic

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Abstract

Background: The COVID-19 pandemic resulted in significant restrictions on dental teaching. The aim of this investigation was to evaluate the attitudes of faculty members towards digital teaching formats and the effort creating digital lectures. We hypothesized that on the lecturer side there is no difference between the various digital teaching concepts in terms of workload and effort and that there is no increase in workload and effort when switching to digital teaching concepts.

Methods: All German dental faculties were invited to the online survey by an anonymous voluntary questionnaire from January to April 2021. The questionnaire consisted of 27 questions that could be answered with a visual analog scale, free text answers, or with fixed answer options. Data was analyzed using the Kolmogorov-Smirnov test and an exploratory data analysis ($\alpha=0.05$).

Results: Before the pandemic, 24.8% of the participating lecturers were using digital teaching and 64.4% had no previous experience. After the outbreak of the pandemic 100% of the dental teaching was initially held online. More than 80% of the lecturers stated that they offer online lectures (86.1%), online seminars (81.2%), and/or online bedside teaching (33.7%). 88.1% see face-to-face teaching as the
preferred teaching format. The lecturers also see the greatest opportunities for interaction in the area of analog teaching and significantly worse in synchronous and asynchronous digital teaching. In the course of the pandemic, respondents' attitudes towards online teaching improved in the median of 24.0 to a median of 50.0.

**Conclusions:** Faculty members have positively changed their attitudes towards online teaching formats over the course of the pandemic. Although they see the greatest learning success in conventional face-to-face teaching formats and the creation of digital lectures is associated with a higher effort, they want more online lessons in the future.

**Keywords**
pandemic, digital teaching concept, lecturer-side evaluation, questionnaire, lecture

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Introduction
The use of digital media in university teaching, also called e-learning, has been a popular form of teaching and learning for more than 20 years and has experienced a significant boom since the 2000s. In particular, students appreciate the flexible online access to the digital teaching tools as well as the individual adaptability regarding different learning speeds. Investigations show, however, that face-to-face teaching, especially personal feedback from the faculty, cannot be completely replaced.\textsuperscript{4}-\textsuperscript{5}

Especially in dentistry theoretical and practical teaching was mostly done conventionally through face-to-face lectures in a lecture hall and treatment room before the outbreak of the pandemic.

The COVID-19 pandemic with its worldwide restrictions in the field of dental education and the need to discontinue face-to-face teaching in many places showed\textsuperscript{6} that the implementation of digital learning as well as teaching support in dental training still has deficiencies.\textsuperscript{7} However, the call for digital teaching concepts, especially web-based offers, became louder.\textsuperscript{8}

The effectiveness of digital teaching concepts has already been proven by numerous authors.\textsuperscript{9-11} Particularly in the area of blended learning, an effectiveness that was not lower than in the case of face-to-face teaching was reported.\textsuperscript{3} The acceptance of distance learning by students has also been examined in numerous investigations and positive results were reported almost without exception.\textsuperscript{10,12-17}

Although the use of digital teaching concepts was extensively described by the students, investigations that examined the topic on the part of the lecturers can hardly be found. In addition to the effectiveness of the teaching method mentioned and the acceptance by the students, the question of the creation effort for digital teaching units, the acceptance on the lecturer’s side and their ability to use digital media is a decisive factor for the increased use of digital teaching concepts within the dental curriculum.

Although Schlenz \textit{et al.},\textsuperscript{18} reported in an investigation about the acceptance of online teaching of a high level of acceptance by both students and lecturers, there is little to be found in the literature on the question of creation effort for online teaching concepts. Zitzmann \textit{et al.}, also assumed in their systematic review of the use of digital teaching concepts in dental education that, despite the considerable effort involved in creating digital courses, a long-term relief of
the teaching effort can be expected, and August et al., proposed that lecturers to work together across universities due to the high time required to create digital content in order to minimize the overall effort, whereas a quantification of the creation effort was not mentioned.

The technological progress of the past 10 years has created countless new options in the field of teaching and enabled to practice digital teaching in different ways. Concerning asynchronous teaching formats, the outstanding strength is that they can be consumed flexibly in time and place and thus made available to a theoretically unlimited audience over a longer period of time. Synchronous formats offer, also without being tied to a specific location, the advantage of direct communication between lecturer and student.

The hypothesis states that on the lecturer side 1. there is no difference between the various digital teaching concepts in terms of workload and effort, and 2. there is no increase in workload and effort when switching to digital teaching concepts and 3. there is no difference in the respondents' attitude towards digital teaching in the course of the pandemic.

Therefore, the aim of this cross-sectional, Germany-wide investigation is to analyze the lecturer-sided acceptance and teaching effort during and after the switch to digital teaching during the pandemic as well as to examine the differences between the various digital teaching concepts as survey-based research. In addition, an insight into the nationwide implementation of dental online teaching is given, as the participants in the study come from many different universities in Germany.

Methods

Ethical statement

A declaration of no objection was approved by the ethics committee of the Medical School (Project KB 20/036) on 10.12.2020. Written informed consent was obtained from participants prior to inclusion in the study.

Study design

All dental schools, like all other universities in Germany were forced to replace their analog lectures in the auditorium during the pandemic period, by different digital teaching concepts. These digital concepts were performed for lectures, seminars, and bedside teaching, whereby the exact use of the various online concepts can now be assumed to be known. Most digital teaching concepts used were:

1. asynchronous (e.g., prerecorded PowerPoint presentations with audio explanations),
2. synchronous using livestreams, and
3. synchronous using conference systems (e.g., Zoom, Big Blue Button, Jitsi as examples).

This cross-sectional study was a survey-based research by an online questionnaire among dental lecturers from different dental schools at German university hospitals, including various departments responsible for dental teaching.

Participant recruitment

All German dental schools were invited for the online survey by sending a link for an anonymous online questionnaire by e-mail. The link was sent directly to the heads of the departments of prosthodontics in all German universities and they forwarded the link to their employees within the department. There were no specific exclusion or inclusion criteria. Participants had to be lecturers at dental schools. The questionnaire time frame for recruitment was from January to April 2021. The questions referred to the period between March 2020 and the time of participation in the study.

Questionnaire development

The questionnaire was generated using an online survey platform (Questionstar, Hannover, Germany) and consisted of 27 questions (Questions: Q) in the German language. A total of seven questions could be answered using a visual analog scale (VAS), three free text answers, and 17 with fixed-answer options (Table 1). The VAS answers were marked by the students with a scroll bar on a line, which reflected the range from 0% to 100% (Figure 1). The questions with fixed-answer options were marked just with a click. Some questions were specifically asked in case the different teaching formats were held. Therefore, it was possible that some questions were not answered by the lecturers if the respective teaching format was not held. Before the questionnaire was sent out, it was validated internally by five highly experienced staff members of the Department of Prosthodontics in Munich. All of these staff members and researchers included are active as lecturers at the University of Munich and have more than five years of experience. The questionnaire was discussed in the research group and checked by the study directors to establish content validity. After validation, a short
### Table 1. Detailed questionnaire used.

| Question No. | Question                                                                 | Answer possibility                                                                                                                                 |
|--------------|--------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 1            | Please specify your gender.                                               | a) Male  
b) Female  
c) Diverse                                                                                                                                  |
| 2            | What is your age?                                                        | a) <30 years  
b) 30-40 years  
c) 41-50 years  
d) 51-60 years  
e) >60 years                                                                 |
| 3            | At which German university are you employed?                             | (Free field to fill in)                                                                                                                                |
| 4            | What position do you currently have at your university hospital?         | a) Guest lecturer  
b) Research assistant  
c) Functional senior physician, senior physician, managing senior physician, director  
d) None of the above positions |
| 5            | How much of your overall work is teaching?                               | a) <25%  
b) 25-50%  
c) 51-75%  
d) >75%                                                                                                                                         |
| 6            | How many years have you been involved in teaching?                       | a) <2 years  
b) 2-5 years  
c) 6-10 years  
d) >10 years                                                                                                                                     |
| 7            | What type of course do you teach?                                        | a) Lectures  
b) Seminars  
c) Bedside teaching  
d) None                                                                                                                                   |
| 8            | Please indicate in what ways you were actively involved in online teaching prior to the COVID-19 pandemic. | a) I have already taught online courses.  
b) I have participated in one or more trainings on the topic of online teaching.  
c) I have studied online teaching on my own.  
d) I have no experience in online teaching before the pandemic. |
| 9            | Where do you most often hold your online lectures from?                 | a) Home office/home  
b) Own office in the university/clinic  
c) Teaching rooms (lecture halls, conference rooms)  
d) No answer                                                                 |
| 10           | What teaching format did you use to implement the online lectures?       | a) Synchronous formats such as live online lectures (e.g. WebEx, ZOOM, BigBlueButton, jitsi).  
b) Synchronous formats such as broadcasts of lectures held analog in the lecture hall and streamed live.  
c) Asynchronous formats such as PowerPoint presentations set to music that are freely available for self-study via online platforms such as Moodle.  
d) Other formats: (Free field to fill in) |
| 11           | What teaching format did you use to implement the online seminars?      | a) Synchronous formats such as live online lectures (e.g. WebEx, ZOOM, BigBlueButton, jitsi).  
b) Synchronous formats such as broadcasts of lectures held analog in the lecture hall and streamed live.  
c) Asynchronous formats such as PowerPoint presentations set to music that are freely available for self-study via online platforms such as Moodle.  
d) Other formats: (Free field to fill in) |
| Question No. | Question                                                                 | Answer possibility                                                                 |
|-------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| 12          | What teaching format did you use to implement the online bedside-teaching? | a) Synchronous formats such as live online lectures (e.g. WebEx, ZOOM, BigBlueButton, Jitsi).  
                  b) Synchronous formats such as broadcasts of lectures held analog in the lecture hall and streamed live.  
                  c) Asynchronous formats such as PowerPoint presentations set to music that are freely available for self-study via online platforms such as Moodle.  
                  d) Other formats: (Free field to fill in). |
| 13          | How often did you have problems with the internet connection, so that you could not or not without problems carry out your online lessons? | VAS (visual analog scale) range: 0% as never – 100% as always.                     |
| 14          | How often did you have problems using the online teaching format, so that you could not or could not carry out your teaching without problems? | VAS (visual analog scale) range: 0% as never – 100% as always.                     |
| 15          | Were you directed which online teaching format to use?                     | a) Yes  
                  b) No |
| 16          | What teaching formats do you prefer to work with?                         | a) Analog teaching formats  
                  b) Online teaching formats |
| 17          | Which online teaching format do you personally like best for lectures and would recommend to others? | a) Zoom/WebEx/Jitsi/BigBlueButton  
                  b) Live broadcast of analog held lectures  
                  c) Prerecorded lectures with audio (e.g. PowerPoint presentation) |
| 18          | Which online teaching format do you personally like best for seminars and would recommend to others? | a) Zoom/WebEx/Jitsi/BigBlueButton  
                  b) Live broadcast of analog held seminars  
                  c) Prerecorded seminars with audio (e.g. PowerPoint presentation) |
| 19          | Which online teaching format do you personally like best for bedside-teaching and would recommend to others? | a) Zoom/WebEx/Jitsi/BigBlueButton  
                  b) Live broadcast of analog held bedside-teaching  
                  c) Prerecorded bedside-teaching with audio (e.g. PowerPoint presentation) |
| 20A         | How high do you generally rate the learning success of courses for students? | a) Analog teaching (Low to high)  
                  b) Synchronous formats such as live online or livestreams of lectures, seminars, etc. (Low to high)  
                  c) Asynchronous formats like PowerPoint presentations with audio (Low to high) |
| 20B         | In general, how would you rate the opportunities for interaction with students during classes? | a) Analog teaching (Highly negative to highly positive)  
                  b) Synchronous formats such as live online or livestreams of lectures, seminars, etc. (Highly negative to highly positive)  
                  c) Asynchronous formats like PowerPoint presentations with audio (Highly negative to highly positive) |
| 21A         | What is your attitude towards online teaching?                             | a) Before the switch to online-only teaching (Highly negative to highly positive)  
                  b) At the present time (Highly negative to highly positive) |
| 21B         | How much theoretical knowledge do you have about online teaching?         | a) Before the switch to online-only teaching (Low to high)  
                  b) At the present time (Low to high) |
| 21C         | How high do you rate your own competence regarding the implementation of an online course? | a) Before the switch to online-only teaching (Low to high)  
                  b) At the present time (Low to high) |
The questionnaires were examined with the statistical program SPSS 26 (IBM, New York, NY, USA) with a significance level of $p=0.05$. Normality of data distribution was analyzed using the Kolmogorov-Smirnov test and an exploratory data analysis. The median values of the questions and the range of deviation of the interquartile range (IQR) were used due to non-parametric analysis. In addition, the Friedmann and Wilcoxon test was performed to compare the results and respective answers.

**Results**

A total of 101 lecturers (46 women, 55 men) participated in the survey with a drop-out of 17 lecturers with incomplete questionnaires (drop-out rate: 14%). All results (100%) showed a deviation from the normal distribution and were consequently evaluated non-parametrically.
Figure 2 shows the distribution of the lecturers at the different universities. A total of 13.9% were under 30 years of age, 35.6% between 30 and 40 years of age, 16.8% between 41 and 50 years of age, 15.8% between 51 and 60 years of age, and 17.8% over 60 years of age.

Among the participating faculty, 3% reported their position within the university as visiting lecturer, 37.6% as research associate, 55.4% as functional/senior physician/chief senior physician or director, and 4.0% with no information.

Regarding the percentage of teaching in the total activity, 13.9% of the lecturers indicated a percentage value of less than 25%, 51.5% indicated a percentage value between 25 and 50%, 28.7% indicated a value of 51 to 75%, and 5.9% of the lecturers even indicated a teaching percentage of more than 75%.

When asked about years of previous teaching experience, 11.9% lecturers reported having less than two years of teaching experience. 18.8% of lecturers indicated teaching experience between two and five years, 17.8% between six and 10 years, and 51.5% with over half of lecturers indicated teaching experience of over 10 years.

Among lecturers, online lectures were presented from the university’s own office by 67.3%, from teaching spaces such as lecture halls or conference rooms by 15.8%, from home office by 13.9%, and 3.0% gave no response. Overall, 86.1% of all lecturers held online lectures, 81.2% online seminars, and 33.7% online bedside teaching since the pandemic initially forced to teach 100% online. Among these, 24.8% of the lecturers reported that they had held online events prior to the pandemic and 25.7% had attended training events on online teaching. 36.6% of the participating lecturers had also dealt with online teaching in self-study before the pandemic. However, 64.4% of the lecturers stated that they had no experience with online teaching prior to pandemic.

62.4% of the lecturers stated that the university had given them the online teaching format. In contrast, 37.6% of the lecturers were able to determine the online teaching format themselves. 88.1% of the lecturers prefer to work with the analog teaching format, i.e., face-to-face teaching, and 11.9% with online teaching. The desired teaching format, depending on the age group is shown in Figure 3.

Figure 2. Overview of universities and distribution of participation in the online survey.
the set to audio seminar e.g., with PowerPoint. For online bedside teaching, 87.7% reported using the Zoom/WebEx/Jitsi/BigBlueButton format, 3.2% a live broadcast of the bedside teaching, and 25.8% the bedside teaching set to audio, e.g., with PowerPoint. In addition, the results on the individual instructional formats showed no correlation between gender and the age group queried.

When asked about problems encountered with the internet and the teaching format, 34.7% of the lecturers stated that they had never had problems with the Internet connection, with the general median being 8.0 (IQR: 35.0). In addition, 37% reported never having had problems using the teaching format, with the median here being 7.5 (IQR: 24.0).

Table 2 shows the separate results comparing the analog and digital teaching formats as well as the conversion of the teaching formats before and during the pandemic.

Table 2. Detailed results of VAS questions comparing different teaching formats using median and IQR (Interquartile range) values. Superscript letters indicate significant differences between answer possibilities.

| Question No. | Question | Answer possibility | Median | IQR |
|--------------|----------|--------------------|--------|-----|
| 20A          | How high do you generally rate the learning success of courses for students? | a) Analog teaching (Low: 0 to high: 100) b) Synchronous formats such as live online or livestreams of lectures, seminars, etc. (Low: 0 to high: 100) c) Asynchronous formats like PowerPoint presentations with audio (Low: 0 to high: 100) | 82.0\textsuperscript{a} 61.0\textsuperscript{b} 50.0\textsuperscript{c} | 37.5 29.5 41.5 |
| 20B          | In general, how would you rate the opportunities for interaction with students during classes? | a) Analog teaching (Highly negative: 0 to highly positive: 100) b) Synchronous formats such as live online or livestreams of lectures, seminars, etc. (Highly negative: 0 to highly positive: 100) c) Asynchronous formats like PowerPoint presentations with audio (Highly negative: 0 to highly positive: 100) | 100.0\textsuperscript{a} 61.0\textsuperscript{b} 0.0\textsuperscript{c} | 19.0 38.5 15.0 |
Figures 4 and 5 represent the amount of online teaching prior and the desire after the pandemic. In addition, Figure 6 shows the respective results divided by gender.

81.2% of the lecturers are of the opinion that online teaching should in principle be more strongly integrated in dental education in the future; for 18.8%, on the other hand, online teaching should not be more implemented.

**Discussion**

The COVID-19 pandemic led to major changes worldwide, especially in social coexistence, as well as work and education. Especially in the field of medical and dental training, which due to their patient-centeredness are related to a high level of physical proximity, fast, alternative solutions had to be sought. An essential way to create infection-preventing distance was the introduction or expansion of digital teaching concepts. Almost all lecturers had to address this often new task.23

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**Table 2. Continued**

| Question No. | Question                                                                 | Answer possibility                                                                 | Median   | IQR  |
|--------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------|----------|------|
| 21A          | What is your attitude towards online teaching?                            | a) Before the switch to online-only teaching (Highly negative: 0 to highly positive: 100) | 37.0\textsuperscript{a} | 49.0 |
|              |                                                                          | b) At the present time (Highly negative: 0 to highly positive: 100)                 | 27.0\textsuperscript{b} | 39.5 |
| 21B          | How much theoretical knowledge do you have about online teaching?        | a) Before the switch to online-only teaching (Low: 0 to high: 100)                  | 37.0\textsuperscript{a} | 49.0 |
|              |                                                                          | b) At the present time (Low: 0 to high: 100)                                       | 27.0\textsuperscript{b} | 39.5 |
| 21C          | How high do you rate your own competence regarding the implementation of an online course? | a) Before the switch to online-only teaching (Low: 0 to high: 100)                  | 68.0\textsuperscript{a} | 35.0 |
|              |                                                                          | b) At the present time (Low: 0 to high: 100)                                       | 69.0\textsuperscript{a} | 28.0 |
| 21D          | How much of a personal workload do you think your teaching job creates for you? | a) Before the switch to online-only teaching (Low: 0 to high: 100)                  | 72.0\textsuperscript{a} | 36.0 |
|              |                                                                          | b) At the present time (Low: 0 to high: 100)                                       | 65.0\textsuperscript{b} | 27.0 |
| 22A          | What was/is your time commitment for creating a lecture?                 | a) Analog lecture (Low: 0 to high: 100)                                            | 71.0\textsuperscript{a} | 29.0 |
|              |                                                                          | b) Digital lecture (Low: 0 to high: 100)                                           | 51.0\textsuperscript{b} | 22.5 |
| 22B          | What was/is your time commitment for delivering a lecture?               | a) Analog lecture (Low: 0 to high: 100)                                            | 51.0\textsuperscript{a} | 24.0 |
|              |                                                                          | b) Digital lecture (Low: 0 to high: 100)                                           | 80.0\textsuperscript{b} | 22.5 |
| 22C          | What was/is your time commitment to update an existing lecture?         | a) Analog lecture (Low: 0 to high: 100)                                            | 63.0\textsuperscript{a} | 31.0 |
|              |                                                                          | b) Digital lecture (Low: 0 to high: 100)                                           | 64.0\textsuperscript{a} | 26.0 |
| 23A          | What was/is your time commitment for creating a seminar?                | a) Analog seminar (Low: 0 to high: 100)                                            | 66.0\textsuperscript{a} | 27.8 |
|              |                                                                          | b) Digital seminar (Low: 0 to high: 100)                                          | 55.0\textsuperscript{b} | 22.8 |
| 23B          | What was/is your time commitment for delivering seminar?                | a) Analog seminar (Low: 0 to high: 100)                                            | 50.0\textsuperscript{a} | 20.5 |
|              |                                                                          | b) Digital seminar (Low: 0 to high: 100)                                          | 78.0\textsuperscript{b} | 33.5 |
| 23C          | What was/is your time commitment to update an existing seminar?         | a) Analog seminar (Low: 0 to high: 100)                                            | 64.0\textsuperscript{a} | 28.5 |
|              |                                                                          | b) Digital seminar (Low: 0 to high: 100)                                          | 58.0\textsuperscript{b} | 23.5 |
| 24A          | What was/is your time commitment for creating a bedside-teaching?       | a) Analog bedside-teaching (Low: 0 to high: 100)                                   | 50.0\textsuperscript{a} | 21.5 |
|              |                                                                          | b) Digital bedside-teaching (Low: 0 to high: 100)                                  | 53.0\textsuperscript{b} | 25.3 |
| 24B          | What was/is your time commitment for delivering bedside-teaching?       | a) Analog bedside-teaching (Low: 0 to high: 100)                                   | 82.0\textsuperscript{a} | 42.5 |
|              |                                                                          | b) Digital bedside-teaching (Low: 0 to high: 100)                                  | 64.0\textsuperscript{b} | 37.0 |

Superscript letters a, b, c indicate significant differences between answer possibilities.
The explosive nature of the topic and the concern of almost all lecturers at German universities caused the high number of participants in the present investigation. Although the survey was not based on personalized links or traceable participation, but on voluntary participation, with 101 participating lecturers, a relatively large field of participants could be registered compared to other lecturer surveys.18,24

The gender and age structure of the present study showed no significant differences between male and female participant numbers between certain age groups. In contrast, the results showed differences in the professional status of the participants. With over 50% of the participants (median 55.4%) the group of the senior physicians, senior physicians; senior consultants or directors are the most frequently represented group. This is not surprising in view of the fact that people in this position often have the predominant teaching performance and teaching responsibility and thus have the highest thematic interest in participating. As a result, most of the study participants were able to state that they had teaching experience of more than 10 years (51.5%).

Figure 4. Results of online teaching of participants prior to pandemic in %.

Figure 5. Results of online teaching desire of participants after pandemic in %.
With 51.5%, more than half of the respondents recorded a share of 25% and 50% in teaching, referred to their entire professional activity. 94.1% of those questioned also stated that more than 25% of their work was done outside of teaching. Clinical dental work beyond of teaching usually does not take place at home. Therefore, many lecturers are tied to one specific location. So at least 94.1% cannot fully exploit the advantages of digital teaching concepts. This restriction could be assumed to be the cause of the fact that only 13.9% of the respondents stated that they teach from home, while 83.1% of the study participants locate their teaching activities in the university (67.3% from the university’s own office and 15.8% from classrooms such as lecture halls or conference rooms). In this regard other authors report similar results. Schlenz et al., identified share of 60.0% of the lecturers who gave lectures from the university’s own office, while 2.9% used specially equipped conference rooms.

Ebner et al., described a worldwide hype of digital teaching at universities, triggered by the pandemic. How much this trend has changed in the field of dental teaching was shown by the question of experience with online teaching. Although the acceptance, the usefulness and the effectiveness of digital learning formats have been described for decades, only 24.8% of respondents said that they had offered digital teaching prior to pandemic. In addition, 64.4% of the participating lecturers had no previous experience. These results were in line with previous investigations. After the outbreak of the pandemic, more than 80% of the lecturers said they were doing online lectures (86.1%), online seminars (81.2%), and/or online bedside teaching (33.7%), which represented a sharp increase.

This rapid development in the implementation of digital content in the dental curriculum also harbors certain dangers. In spring 2020, COVID-19 caused considerable restrictions in dental teaching. The rapid changes in university teaching that became necessary as a result hit the universities and lecturers suddenly. As the present study shows, only 25.7% of the respondents were able to state that they had taken part in corresponding advanced training events on digital teaching by the time the pandemic broke out, and 36.6% of the respondents had dealt with the topic at least in self-study.

It can be assumed that, not least because of the lack of experience with digital teaching concepts until then, the selection of the teaching format was specified by the university for 62.4% of the participants. Against the background of countless digital possibilities in the field of teaching, this appears to be a sensible measure to create clear university structures. In addition, the license agreements represented a certain university restriction and focus on individual suppliers. Since a large number of students must be able to attend synchronous lectures, seminars, and bedside teaching in digital formats, licenses are often unavoidable.

Although authors who examined the acceptance of digital teaching concepts on the part of students reported very high acceptance values, combined with the demand for more online teaching, this development was not clearly reflected on the part of the lecturers.
With 88.1% of the respondents, the vast majority indicated that classroom teaching was the preferred form of teaching, despite having had experience with digital teaching in the meantime. The reasons for this were certainly multilayered. For many lecturers, one reason could be the sudden need for digital offers combined with a lack of previous experience. This situation possibly led to excessive demands, at least temporarily. It should not be forgotten that digital teaching concepts also has disadvantages that are often described, such as eye fatigue from working on the screen and thus a decrease in receptivity or a lack of motivation. Another decisive disadvantage of digital teaching concepts is the reduced interaction both between students and between students and lecturers. The selection of the teaching format suggests that this point is not insignificant on the lecturer side. Although formats in which discussed slides are used and which can be called up repeatedly, if necessary, with slight modifications, can be ‘recycled’ again and again, the preferred teaching formats, regardless of the type of course, were the “live” formats such as Zoom, WebEx, Jitsi, or BigBlueButton. These formats allow for more direct communication.

At the same time, the participants also evaluated the learning success of analog teaching as the greatest. On a scale from 0-100, the participants gave the analog lessons a median value of 82.0 for learning success, while digital, synchronous formats were rated significantly worse with a median value of 61.0. The participants rated the digital asynchronous teaching significantly worse.

The participants evaluated the differences in the interaction options with similar clarity, but even more clearly. Corresponding to the assessment of the learning success, the respondents see the greatest opportunities for interaction in the area of analog teaching (median 100.0). The opportunities for interaction with synchronous digital teaching (median 61.0) are seen as significantly worse. In asynchronous digital teaching, the lecturers see almost no opportunity for interaction (median 0.0).

Although a majority of the lecturers still prefer to use analog teaching and consider this to be more productive, the attitude towards online teaching has changed positively. While the respondents rated their attitudes towards online teaching on a scale of 0-100 with a median of 24.0, this improved during the pandemic to a median value of 50.0.

At the same time, however, in the relatively short period of the pandemic, the lecturers neither had the perceived knowledge of digital teaching concepts (before median 60.0 after 77.0) nor the perceived competence in the implementation of digital content (before median 68.0, After 69.0) significantly improved.

Surprisingly, the surveyed lecturers did not perceive any difference in the workload of their teaching activity between the workload before and during the pandemic. Although there was a tendency to describe additional effort before the pandemic, it was not statistically significant. When asked about the effort required to create individual teaching formats, a mixed picture emerges. While a significant additional effort is seen in the creation of lectures with digital formats (analog median 50.0, digital median 73.0), there is no significant difference between the creation of digital and analog formats when creating seminars and bedside teaching. This result could possibly be explained with the workflow of the various creation modes. While bedside teaching and seminars focus on working out certain issues in small groups, the lecturer takes the active part in lectures, while the students usually only receive the information. The second one is therefore better suited to be reproduced multiple times in asynchronous form. However, due to the storage of audio files, this requires more creation effort than digital lectures. The seminars or bedside-teaching, which are mostly offered as synchronous formats, differ little in terms of creation effort from their analog form.

When presenting the teaching units, on the other hand, the respondents see a significant additional effort both in the area of the lectures and in the area of the seminars. Only with bedside teaching a significant additional effort is seen in the analog form of learning.

When updating existing teaching units, however, this difference was small, so that no significant difference could be analyzed either in lectures (analog median 63.0, digital median 64.0) or in seminars (analog median 64.0, digital median 58.0).

Basically, the results clearly show how university dental teaching has changed since the pandemic. As already described in previous studies, the surveyed lecturers would like to continue online teaching after the pandemic. While the respondents in this study estimated the median proportion of their online teaching before the pandemic to be 4.8% (SD ± 11.44), they hope for a proportion of 40% (SD ± 25.8) in the future. The results suggest that female lecturers in particular are in favor of implementing more online teaching (male 30 %, female 50%).

Due to its high proportion of crucial practical skills, dental training is not suitable for being fully taught in distance learning. However, the results show that there is a high level of willingness on the part of the lecturers to continue to...
design at least the theoretical part of the training digitally. At the same time, the participating lecturers point out the weaknesses of digital teaching in the area of interaction, which should be reduced as much as possible by choosing the appropriate format.

The present study had some limitations, on the one hand, in the composition of the field of participants and, on the other hand, in the circumstances in which the switch to digital teaching took place.

Since participation in this study was voluntary, a field of participants that was unevenly large between the various universities emerged. In order to take this fact into account, the present results must be viewed taking into account the weighting shown in Figure 2. Voluntary participation also means that only the more motivated employees pre-selectively declared themselves study participants. As we had no information about how many employees of the other universities received the questionnaire and how many did not participate, it was not possible to determine a drop-out rate.

Moreover, despite the large number of universities that participated in the survey, the number of participants was nevertheless reduced. It would be useful to repeat the survey at a later date, possibly with an international scope, and to compare it with the results of the present study.

Another limitation is the current situation under which the switch to digital teaching offers was mostly not voluntary. Here it would be advisable to collect the results again in further studies with a suitable interval. This would allow a realistic assessment of the attitudes towards digital teaching concepts on the part of the lecturers.

In summary, it can be stated that although the study participants offer significantly more digital teaching in times of the pandemic and have significantly positively changed their attitude towards online teaching, the learning success with analog teaching is rated highest. In the case of lectures in particular, the participating lecturers see a considerable amount of additional work involved in creating digital files. In general, the teachers at German universities are positive about the increased use of digital teaching and hope to be able to offer a far higher proportion of the teaching units digitally in the future.

**Conclusion**

Within the limitations of the present cross-sectional survey-based investigation, the following conclusions could be drawn:

1. Faculty members positively changed their attitude towards online teaching formats during the COVID-19 pandemic.
2. Lecturers rated the learning success with analog face-to-face teaching formats the highest.
3. Lecturers evaluated an additional effort in creating digital lectures.
4. More online teaching would be preferred by lecturers in the future.

**Data availability**

**Underlying data**

Open Science Framework. Dental education during the pandemic – cross-sectional lecturer-side evaluation for the use of digital teaching concepts. [https://doi.org/10.17605/OSF.IO/QD9KT](https://doi.org/10.17605/OSF.IO/QD9KT)

The project contains the following underlying data:

- Excel_File_b.xlsx. (raw underlying data of anonymized questionnaire responses).
- Excel_File_b.csv. (raw underlying data of anonymized questionnaire responses).

**Extended data**

The project contains the following extended data:

- Questionnaire unvalidated. (Original unvalidated questionnaire in English).
• Questionnaire unvalidated German. (Original unvalidated questionnaire used in German).
• Questionnaire Final validated (Final validated English questionnaire used in this study).
• Questionnaire Final validated German (Final validated German questionnaire used in this study).

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

Acknowledgments
The authors would like to thank all participating lecturers at the various German dental schools for their support and participation in the survey.

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Publisher Full Text
Open Peer Review

Current Peer Review Status: ✅ ✅ ❓

Version 2

Reviewer Report 10 November 2022

https://doi.org/10.5256/f1000research.140113.r155404

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Maximiliane Amelie Schlenz
Department of Prosthodontics, Justus-Liebig-Universität Giessen, Giessen, Germany

The authors addressed all concerns well. I suggest publishing the manuscript. Thank you very much for this valuable data!

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: digital dentistry, intraoral scanners, restorative dentistry, clinical dentistry, dental education, dental materials, implant prosthetic, removable and fixed prothodontics, gerodontology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 10 November 2022

https://doi.org/10.5256/f1000research.140113.r155403

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Mohammed Gamal
Department of Pharmaceutical Chemistry, College of Pharmacy, Al-Jouf University, Aljouf, Saudi Arabia

The authors replied for all reviewers' comments in the first round in a very professional way. The
paper could be published now in the current form. I appreciate their efforts.

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** pharmaceutical chemistry, green chemistry, instrumental analysis, medical survey research, clinical sciences

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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**Version 1**

Reviewer Report 11 October 2022

https://doi.org/10.5256/f1000research.134243.r151554

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Jens Christoph Türp

University Center for Dental Medicine Basel UZB, Department of Oral Health, University of Basel, Basel, Switzerland

The article by the five authors addresses a timely topic: teaching in times of the Covid 19 epidemic. Specifically, they examined how digital teaching in dentistry (here: prosthodontics) has changed as a result of the pandemic – and how faculty have responded to the unexpected challenges. I will share my impressions, comments, and suggestions below. Before doing so, I would like to emphasize that I agree with all the suggestions made by the reviewer Maximiliane Amelie Schlenz (University of Giessen). Therefore, I will not address the manuscript-related points mentioned by her in my review.

In the following, I will present my points in chronological order according to the sequence of the individual parts of the manuscript.

**ABSTRACT**

(1) Background: the authors should better visually emphasize the two aims of their study by labeling them "(a)" and "(b)": "The aim of this investigation was to evaluate (a) the attitudes of [...] and (b) the effort creating digital lectures." 

(2) Results: The precise numbers (24.8%, 64.4%, 86.1%, 81.2%, 33.7%, etc.) given to one decimal place suggest a mathematical accuracy, which in reality – not least because of the methodology (see later) – is rather due to chance. It would therefore be more advantageous to paraphrase the calculated values linguistically instead, e.g., by writing "a quarter", "far more than half", "the vast majority", "about a third", etc.

(3) Results: In contrast to the German language, sentences in English must not begin with Arabic
numerals (“88.1% see face-to-face teaching”). Instead, in such cases, the numbers are written out. In this specific case, however (see point 2 above), a paraphrase like "Four out of five lecturers see ..." would be the better linguistic choice.

(4) Results: Results are presented by the authors only for the first objective, but none for the second aim (effort/workload).

(5) Results: The first two sentences of the results provide information for which no aim was provided in "Background". Therefore, one could add another – first – aim there: "[...] was to evaluate the changes in the percentage of digital teaching."

(6) Conclusions: they are relatively trivial. The results provide possibilities for a more attractive conclusion.

INTRODUCTION

(1) 2nd paragraph, end of the first sentence: "still has deficiencies". The reader would certainly like to know which deficiencies are involved.

(2) 3rd paragraph, second sentence: "blended learning". A brief explanation of what is meant by this term would be helpful since it cannot be assumed that all readers of the article are familiar with it.

(3) 4th paragraph, first sentence: (a) "described by the students". Which students are meant and to what does this statement refer? (b) "Investigations" can no more be "found" than studies can be read. Investigations/studies are planned, funded, conducted, and completed, but never found or read. What is "found" are articles in a literature search, and what is "read" are articles about a study.

(4) Paragraphs 4 and 5: Both begin with "Although". This can easily be improved.

METHODS

(1) 2nd paragraph (Study design): This paragraph belongs in the introduction.

(2) 3rd paragraph (Participant recruitment): "All German dental schools". The reader would certainly like to know how many dental schools there are in Germany.

(3) 3rd paragraph (Participant recruitment): Of great importance is an indication of whether there was a maximum number of study participants per site – and if not, why not. If you look at Figure 2, you can see why this question is important (possibility of bias in the results). The authors should also mention whether external lecturers, i.e., lecturers not permanently employed at the dental clinic (e.g., lecturers working in private practice [external senior physicians/dentists; Privatdozenten; adjunct professors]) were also allowed to participate in the study.

(4) 4th paragraph (Questionnaire development): The explanations are partly incomprehensible, especially the third last sentence ("After validation, a short cut was created from ..."). More detailed explanations are required here. The aim of a good methodology section should always be to enable the reader, at least theoretically, to repeat the study without asking the authors. For this purpose, the authors must disclose from the beginning everything that is necessary to understand the applied methodology.

(5) 5th paragraph (Data analysis): "The questionnaires were examined with ...". By whom were they examined/evaluated?

(6) Figure 1: The scale should have two anchor points labeled "0" and "100".

RESULTS

(1) Fig. 2: It is clear from this figure that the results obtained in this study are very unlikely to be representative of dental prosthodontic teaching in Germany, but rather a biased sample. Of the 30 (?) dental universities in Germany, only 18 are represented in this study. These 18 are weighted
differently. Not unexpectedly, study participants from the University of Munich make up the majority with about one-fifth of the total number. Interestingly, no one from the University of Cologne, where one of the authors is from, participated. This bias does not devalue the study, but it does diminish its general validity. This drawback should be highlighted more in the discussion than the authors do in a brief section toward the end of the discussion.

(2) In the text, as already mentioned above in the "Abstract" section, pseudo-exact numerical values should be avoided in favor of rounding or linguistic descriptions. What on earth are "34.7% of the lecturers" in view of 84 participants ("101 lecturers" minus "17 lecturers with incomplete questionnaires"; see Results, 1st par.)?

(3) Paragraph 8: "lecture with audio, e.g., with PowerPoint". PowerPoint is primarily visual, not audio.

(4) Paragraph 9: What exactly do the "general medians" indicate? What do they refer to? How do the numerical values come about?

(5) Table 2: The given values of the medians and IQR should be at the level of the respective answer options a), b) and c).

DISCUSSION

(1) A good discussion always starts with the highlight of the study results ("Where is the meat?")

(2) The discussion is unnecessarily long. The probability that an article will be read increases if it is kept short.

(3) What has been pointed out before also applies to the discussion: Avoid giving exact numbers from the study.

(4) The authors compare the two teaching formats analogue (lecture hall; seminar room) versus digital (computer). Possibly, however, another aspect plays a role: the lecturer. After all, until the beginning of the pandemic, holding online lectures was never an issue for her/him. Now she/he is forced to speak into a microphone in an unfamiliar environment (her/his office, her/his home) and an unfamiliar format, sitting in front of his computer. You could say: instead of a familiar theatre performance, she/he is suddenly forced to deliver a radio play, a format completely unfamiliar to her/him. This change is not easy for every lecturer. Consequently, some lecturers deliver a presentation that is below the standards they have been used to in the lecture hall; in addition, they have to deal with technical problems, speak in a monotone voice, etc. In such cases, however, the differences in the evaluations concern less the teaching format, but rather the performance of the lecturer. This aspect should be examined more closely in the discussion.

(5) Paragraph 14: "bedside-teaching". Do the authors mean "chairside teaching"?

(6) Paragraphs 15 and 16: Both start with "When".

CONCLUSION

(1) What does the following sentence mean: "Lecturers evaluated an additional effort in creating digital lectures"?

REFERENCES

(1) Ref. 29 and 30: The titles of the papers are given in English. However, the articles have been published in German. The corresponding original German titles are:
29: Organizational Embedding of E-Learning at German Universities. Institute for Information Management Bremen
30: Change Management in Higher Education: The Sustainable Implementation of e-Learning
Innovations.
A disregard of the original title and replacement of the same by an own translation (which in the
case of reference 30 is inaccurate, since it should read: Change Management in University
Teaching: The Sustainable Implementation of e-Learning Innovations) is not permitted without a
corresponding note.
(2) The following literature should be included1,2,3

GENERAL REMARKS
(1) The text needs linguistic (English) improvement.
(2) Sentences in scientific English are shorter than in German. Therefore, two shorter sentences
are better than one long one.

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Abstract | Publisher Full Text

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
I cannot comment. A qualified statistician is required.

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Evidence-based dentistry, orofacial pain, temporomandibular disorders,
occlusion

I confirm that I have read this submission and believe that I have an appropriate level of
expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Mohammed Gamal
Department of Pharmaceutical Chemistry, College of Pharmacy, Al-Jouf University, Aljouf, Saudi Arabia

The article is very interesting. It is very well written in a very clear language. It worth publication after minor revisions.

1. Title should be modified to be dental education in Germany to reflect the geographical location for the study.

2. The following article should be cited

3. Comparisons of dental education studies from lecturers points of view from different developed countries e.g. UK, USA, during pandemic should be stated and illustrated in discussions.

4. Introduction should be ended with the main aim of the research paper. Therefore, I recommend reorganization of the last paragraph in introduction to be above aim statements “The hypothesis states that on the lecturer side 1. There is no difference between the various digital teaching concepts in terms of workload and effort, and 2. There is no increase in workload and effort when switching to digital teaching concepts.”

5. Date of ethical statement should be provided.

6. In study design [All dental schools, like all other universities] add in Germany.

7. In table 2, results should be aligned with choices i.e. in the same level on the same line.

8. Future research plans and study limitations should be provided.

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**Is the work clearly and accurately presented and does it cite the current literature?**
Partly

**Is the study design appropriate and is the work technically sound?**
Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**
Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**
Yes

**Are all the source data underlying the results available to ensure full reproducibility?**
Yes

**Are the conclusions drawn adequately supported by the results?**
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** pharmaceutical chemistry, green chemistry, instrumental analysis, medical survey research, clinical sciences

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

---

**Author Response 20 Oct 2022**

**Anja Liebermann,** University of Cologne, Polyclinic of Prosthetic Dentistry, Cologne, Germany

Dear Mr Gamal,
Dear Ms Schlenz,

Thank you for taking the time to edit our article.

We tried to consider your comments to the best of our knowledge.
We changed the title of the manuscript, as suggested by Mr. Gamal and Ms. Schlenz, and incorporated the references described by Mr. Gamal in the Introduction chapter.
Unfortunately, we could not find any comparable studies in dentistry that examine the change in teaching from the lecturer’s perspective during the pandemic. We will pursue the literature on this topic and supplement the article if necessary. In the Introduction chapter, we took up Mr. Gamal’s suggestion and reorganized the last paragraph.

Furthermore, we have included the date of the ethical statement in the text and added in the study design that the universities in question are all located in Germany. In the discussion, we described in more detail the limitations of this study.

The mentioned formatting in Table 2 presented us with challenges. While the criticism for the PDF format is valid, in the online version of the article the results are aligned with choices in the same line. We provided Table 2 with appropriate values (Low:0, high:100). The same applies to the font size of the illustrations mentioned by Ms. Schlenz. Again, the criticism only applies to the PDF version of the article, but not to the online version. Appropriate formatting of f1000research may help here.

We have gratefully complied with the notification of the uniform formulations. We also briefly described the established German presence concept and expanded the hypotheses to include this aspect. Also, we added the requested period to the article. In order to enable better interpretability of the data, we have provided the scroll bar with the appropriate values (0 to 100).

We hope to have taken up your suggestions in the desired way and remain with kind regards.

**Competing Interests:** No competing interests were disclosed.
German Dental Schools is of high interest, not only limited to the topic of teaching during the COVID-19 pandemic, but rather for new digital teaching opportunities related to the new medical licensure act for dentistry in Germany. Furthermore, this study provides valuable information for lecturers around the world that like to implement or improve digital teaching in dental education. I have to emphasize the elaborate Discussion section and clear subsumption of the results to the available literature.

Answers to F1000 questions according to guidelines for reviewing:

- The study design is appropriate and the work have an academic merit.
- The work is clearly and accurately presented and the relevant current literature is cited.
- The materials and methods section contains sufficient details to replica the study by others.
- As far as I can see, the source data underlying the results are available.
- The statistical analysis is appropriate and well interpreted.
- The conclusions drawn are adequately supported by the results of the study.

From my point of view, the manuscript is general acceptable for publication. However, I suggest to address the following small points:

1. Please, revise the manuscript regarding a consistent wording (e.g. analog or conventional, classroom teaching or event). Otherwise, the readers might get confused.

2. I suggest to revise the title: “Dental education during the COVID-19 pandemic – cross-sectional lecturer-side evaluation for the application of digital teaching concepts”.

3. Please, extend the null hypothesis regarding the aspects “handling/attitude” (Questions 10-21C) towards digital teaching. These valuable aspects are not addressed in the null hypothesis yet, because only workload and effort are considered.

4. I suggest to add a paragraph describing the established German face-to-face teaching concept to the introduction section, because in other countries digital concepts might be already implemented before COVID-19 pandemic.

5. Add the investigated aspects “handling/attitude” (Questions 10-21C) to the Introduction section and highlight more the key aspect of your questionnaire survey not investigating just one single dental school, but rather including all locations in Germany.

6. Please, add the period that you asked the lecturers for. I guess you were interested in the period March 2020 to January 2021?

7. For better clearance, add the measured data (0 to 100) to the scroll bar in Figure 1. Otherwise, it is a little bit difficult to interpret data of Table 2. In addition, I suggest explaining the analysis of the scroll bar in the legend of Table 2 and design the column “Answer possibility” clearer.
8. Please, increase the font of Figure 2-6.

I suggest to approve the manuscript with reservations.

Good luck and keep well!

**Is the work clearly and accurately presented and does it cite the current literature?**
Yes

**Is the study design appropriate and is the work technically sound?**
Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**
Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**
Yes

**Are all the source data underlying the results available to ensure full reproducibility?**
Yes

**Are the conclusions drawn adequately supported by the results?**
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** digital dentistry, intraoral scanners, restorative dentistry, clinical dentistry, dental education, dental materials, implant prosthetic, removable and fixed prosthodontics, gerodontology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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**Author Response 20 Oct 2022**

**Anja Liebermann,** University of Cologne, Polyclinic of Prosthetic Dentistry, Cologne, Germany

Dear Mr Gamal,
Dear Ms Schlenz,

Thank you for taking the time to edit our article.

We tried to consider your comments to the best of our knowledge.
We changed the title of the manuscript, as suggested by Mr. Gamal and Ms. Schlenz, and incorporated the references described by Mr. Gamal in the Introduction chapter.
Unfortunately, we could not find any comparable studies in dentistry that examine the change in teaching from the lecturer's perspective during the pandemic. We will pursue the literature on this topic and supplement the article if necessary. In the Introduction chapter, we took up Mr. Gamal's suggestion and reorganized the last paragraph.

Furthermore, we have included the date of the ethical statement in the text and added in the study design that the universities in question are all located in Germany. In the discussion, we described in more detail the limitations of this study.

The mentioned formatting in Table 2 presented us with challenges. While the criticism for the PDF format is valid, in the online version of the article the results are aligned with choices in the same line. We provided Table 2 with appropriate values (Low:0, high:100). The same applies to the font size of the illustrations mentioned by Ms. Schlenz. Again, the criticism only applies to the PDF version of the article, but not to the online version. Appropriate formatting of F1000research may help here.

We have gratefully complied with the notification of the uniform formulations. We also briefly described the established German presence concept and expanded the hypotheses to include this aspect. Also we added the requested period to the article. In order to enable better interpretability of the data, we have provided the scroll bar with the appropriate values (0 to 100). We hope to have taken up your suggestions in the desired way and remain with kind regards.

**Competing Interests:** No competing interests were disclosed.
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