Post-pandemic Online Mathematics and Statistics Support - practitioners' opinions in Germany and the British Isles

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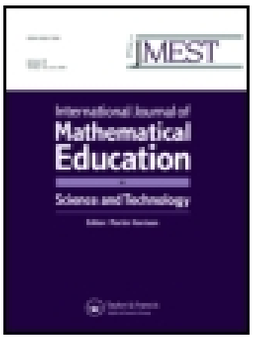

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Post-pandemic online mathematics and statistics support: Practitioners' opinions in Germany and Great Britain & Ireland

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ABSTRACT

Mathematics and statistics support (MSS) plays an important role at many universities. Typically, support has been provided in person, but during the COVID-19 pandemic, online provision was required. This paper reports on a scoping study comparing how support services changed during the pandemic at institutions in Germany and Great Britain & Ireland (GBI), exploring how well online MSS worked, and what can be learned for the future. As MSS in Germany differs in history and structure from that in GBI, we contrast results from the two locations. A total of 82 participants from 44 individual institutions answered an online questionnaire. Although at first, support was used less by students, engagement has begun to recover. The survey included questions addressing issues raised in previous studies, and answers showed notable differences between the two jurisdictions. In GBI, service providers felt that students with low confidence or time restrictions can benefit from online provision. In Germany, online spaces for student collaboration without tutoring was found helpful. Even though most respondents want a return to face-to-face, practitioners are aware of the benefits of online support, and it becomes apparent that certain services will still be offered online and could especially serve specific student groups.

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Mathematics and statistics support; academic support; digital support; online learning; COVID-19 pandemic

1. Introduction

1.1. Background – mathematics and statistics support in Great Britain & Ireland and Germany

Mathematics and statistics support (MSS) has been an established part of the academic support infra-structure in universities throughout Great Britain & Ireland (GBI) for many years. MSS was originally introduced to mitigate the high drop-out rates on technical courses believed to be caused by the mathematical under-preparedness of incoming undergraduates (see, for example, Hawkes & Savage, 2000; LMS, 1995; National Audit Office, 2007). Following the title of LMS (1995), this issue of mathematical

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under-preparedness became known as 'The Mathematics Problem'. The principal idea behind MSS is to provide support tailored to the particular needs of individual students which is in addition to their regular programme of teaching in lectures, tutorials, etc. (see Lawson et al., 2003 for an oft-quoted definition of MSS).

The first recorded survey of MSS provision in the United Kingdom took place in 1993 (Beveridge & Bhanot, 1994). Since then, the number of institutions in GBI providing MSS has increased steadily, as evidenced in various surveys, such as Perkin et al. (2013), Grove et al. (2019), Ahmed et al. (2018) and Cronin et al. (2016). The most common form of MSS is the Mathematics Learning Support Centre (MLSC). Typically, this is a dedicated room which provides both drop-in access to tutors and a location for individual or small group study. Some institutions offer pre-booked tutor appointments instead of, or in addition to, drop-in support. With general advances in IT and, in particular, the huge increases in what can be delivered over the internet, most MSS providers have developed their own web presence (Mac an Bhaird, Mulligan, et al., 2021).

Although MSS can be regarded as a grassroots, practitioner-initiated phenomenon, having been developed by academic staff as a way of meeting the needs of their students, in recent years it has been underpinned by a substantial amount of research. Matthews et al. (2013) provided a review of methods of evaluating MSS whilst Lawson et al. (2020) gave a broader summary of the state of research in the field of MSS (not only evaluation of MSS) at the end of the second decade of the twenty-first century. The overwhelming majority of the research reported comes from GBI, with a smaller amount from Australia and the U.S.

The Mathematics Problem, however, is not limited to the English-speaking world, although other parts of the world may have tackled it a little later. In Germany, for example, a recent study has confirmed high drop-out rates in mathematics and scientific and technical disciplines (Heublein & Schmelzer, 2018) that had been reported earlier (Heublein et al., 2008; compare also Fischer et al., 1975). Previous work indicates that mathematical under-preparedness is likely to be a significant factor in the high drop-out rates (Heublein et al., 2010; Kaiser & Buchholtz, 2014). The most common measure introduced in German universities to address this problem was the bridging course (Bausch et al., 2014). A bridging course is a programme of study, delivered by a university, which takes place before the first semester of a bachelors programme whose purpose is to 'bridge' the gap between the mathematical skills of students on leaving school or college and those required for successful study in higher education.

Whilst bridging courses have shown some success, they have not been a total panacea (Lankeit & Biehler, 2022). Consequently, other support measures have been introduced. This has particularly been the case in the last ten years due to the large national programme to improve the quality of higher education across all domains (Teaching Quality Pact [Qualitätspakt Lehre]) which has provided substantial amounts of funding for new initiatives. As part of this programme, several German universities have introduced some kind of MSS, typically a MLSC, in an attempt to reduce drop-out rates and improve student outcomes. A recent national survey in Germany (Schürmann et al., 2021) found 61 MLSCs at 51 universities (out of 180), with an additional 16 support centres focused on mathematics didactics, targeting preservice teachers.

Evaluations of initiatives in Germany designed to offset the Mathematics Problem are not as extensively published as in GBI. However, in recent years, particularly, but not

exclusively, driven by the German Centre for Higher Mathematics Education (khdm; Biehler et al., 2016) research has begun to emerge. Bridging courses, being the most common form of support, have been studied (Bausch et al., 2014; Lankeit & Biehler, 2022). However, work focusing on MLSCs is more limited. Hochmuth et al. (2018) published a study of six such centres, but this was a convenience sample rather than a representative one and Schürmann and Schaper (2022) reported in more detail on the MLSCs that participated in the WiGeMath[1] project. The aforementioned survey by Schürmann et al. (2021) is the first piece of work to attempt to gain an understanding of the national picture regarding MLSCs in Germany. It is anticipated that with the creation of a national network, LemMa,[2] of MLSC providers, the pace of research will increase as it did in GBI following the creation of the **sigma** network.

Although MSS provision is broadly similar in Germany and GBI, there are some important differences, which may, in part at least, be due to the relative newness of the German provision. In GBI, there is currently much emphasis on the provision of statistics support. The early literature in the field referred to mathematics support, but more recently it has become common to use the term mathematics and statistics support (as we do in this paper) to emphasize both the growing importance and different nature of statistics support. In Germany, the focus is still primarily on mathematics support, with little or no special or separate attention given to statistics support.

There are differences too in terms of the nature of the staff who deliver MSS. Although student tutors are widely used in GBI, there is a growing body of academic staff who are engaged in specialist MSS roles. In Germany, the MSS provision is often overseen by a regular member of academic staff (who has other traditional teaching duties as well), with the tutoring carried out predominantly by student tutors or a mixed team of staff and student tutors (Schürmann et al., 2021).

2. The COVID-19 pandemic and mathematics and statistics support

Before the COVID-19 pandemic, the overwhelming majority of MSS provided across GBI and in Germany was delivered in a face-to-face environment. Online technology was used as a means to deliver resources via websites, but synchronous online interactions between tutors and students were rare (Cronin & Breen, 2015; Grove et al., 2019; Mac an Bhaird, McGlinchey, et al., 2021). It had been thought that the nature of the interactions between tutor and student, including the need to write formatted mathematical text on a shared surface and the frequent need to check understanding, could not take place in an appropriate way in an online setting (Trenholm & Peschke, 2020).

The introduction of 'lockdown' and other measures intended to reduce the spread of the COVID-19 virus across the world, required changes in practice in the whole of higher education. MSS was no exception. The choice was either to move MSS online in some form, no matter what reservations practitioners may have had about its efficacy, or to have no MSS provision. Along with the wider higher education community, MSS practitioners took the first option.

The speed with which lockdown and other measures were introduced in March 2020 gave very little time for preparation – providers needed to act quickly. The first phase of the MSS response to the measures has been characterized as a crisis reaction (Mullen et al., 2021a). In GBI and Germany, the academic year 2019/20 was nearing completion when

these measures were introduced. Once the academic year had been completed, there was an opportunity to reflect on successes and failures during the crisis reaction phase and to modify online MSS provision for the beginning of the academic year 2020/21.

Although much effort was needed simply to implement online MSS, the community realized that it was important to document successes (and failures) and to research the provision of extensive online MSS. Hodds (2020a), published only a few months after the start of the crisis reaction phase, presents the results of a survey documenting what practitioners actually did in this initial period. More than 90% of institutions surveyed offered at least one form of online support, of which pre-booked online one-to-one sessions were most frequently used in the U.K., and an online general drop-in service for institutions outside of the U.K. However, at this point, with a significant decline in student engagement, many practitioners felt they were not adequately trained to support students online and the majority felt in person support was superior.

This has been followed by further work which investigated the more considered provision of online MSS in 2020/21 as well as in the initial period at the end of 2019/20. Gilbert et al. (2021) explored practitioner opinion of online support provision in May 2020 survey data and again in interview data from January and February 2021, with a focus on the future of MSS provision. The most common characteristics among responses in May 2020 were uncertainty and negativity towards online support, contrasted by 100% of interviewees in January and February 2021 stating they would continue with some form of online support once restrictions lifted.

Mac an Bhaird, McGlinchey, et al. (2021) report the findings from an anonymous student survey exploring the provision of online support at Maynooth University, with a focus on online study groups. Students described that small study groups increased their confidence by giving them the opportunity to listen to their peers in a less intimidating environment than large groupings of students, with regular scheduling supplying structure and motivation. In contrast, negative themes impacting engagement with support described issues with timetable clashing, not knowing where or when the support was available, limited interaction with peers and the online environment creating feelings of anxiety and discomfort.

O'Sullivan et al. (2021) investigate student interaction data with online mathematics learning support (OMLS) at Cork Institute of Technology. Researchers found that although initial use of the resource was high, time spent using it was low with limited return users. Hence, they recommended that OMLS resources should be designed with students' first impressions in mind, particularly the home page and navigation menu. Content should be tailor-made to target specific groups, with opportunity for discussion and clear signposting.

Finally, Mullen et al. (2021a, 2021b) explore differences in MSS provision during the pandemic in two universities, one in Ireland and the other in Australia. They used a case study approach, collecting data from interviews with seven students and four tutors from Western Sydney University and with six students and six tutors from University College, Dublin. Although circumstances for both institutions were different, the impact of the shift to online provision was similar, particularly the appreciation of communication and interaction: peer-to-peer learning for students, and loss of unspoken communication for tutors (2021a). Other key themes included lower engagement with online support, learning mathematics being different to learning other subjects, including the regularly reported issue of mathematical notation in an online environment, and in person support being

preferable but acknowledgment of online support being effective in certain situations (2021b).

In this work, we also compare MSS in two different geographical locations: GBI (i.e. Great Britain & Ireland) and Germany. However, rather than using a case study approach, this work sets out to be a scoping study which views, at a high level, the overall situation across each location through the use of surveys with participants from across the breadth of both locations. The findings of this scoping study can be used to inform further studies using other data gathering techniques, such as interviews and focus groups, to probe further into issues identified.

3. Research questions

Informed by the findings of previous work, notably Hodds (2020a) and Gilbert et al. (2021), with our study we aimed to answer the following research questions. The first two research questions are focused on what actually took place during the pandemic, RQ3–RQ6 ask the respondents to reflect on the pandemic period as a whole, and RQ7 explores future thinking.

> RQ1: During the pandemic, and the partial lock down of universities, what kind of mathematics and statistics support was provided by MLSCs to students?

As the situation at universities in Germany and BGI was different during the pandemic and most universities had to partially lock down face-to-face teaching and drop-in services, we asked practitioners to give detailed information on the services provided by the MLSCs to the students in this phase.

> RQ2: From practitioners' perspectives, how did the level of use of support change from before to during the pandemic situation?

We anticipated that during the pandemic the amount of use of online one-to-one support for students might have changed over time. We expected that the shift to online support needed time for infrastructure and new processes to be established and as students and tutors became more familiar with the general online learning environment, so levels of use might change over time.

> RQ3: What types of tutor/student and student/student interactions take place in online support?

We knew of differences between each country of our study and between practitioners in terms of experiences with online support due to use of different software and technical equipment. Therefore, we wanted to assess these different experiences like the use of cameras and ways of determining student understanding.

> RQ4: How effective has advertising online MSS been?

Hodds (2020a) highlighted that traditional means of advertising MSS (such as peer recommendation by word of mouth) may not be effective during the pandemic when all learning is online. Since awareness of the existence of the provision is crucial to its usage, we determined this was an important area to investigate.

> RQ5: How did practitioners' views change over time?

We assumed that as practitioners gained experience in the new mode of delivery, their views might change. They may become aware of advantages they did not expect or their views about disadvantages may be confirmed. These things would only become apparent after some time. We were thus interested in changes that might have occurred.

RQ6: What benefits or disadvantages do practitioners see in online support?

As already stated, prior to the pandemic, the commonly held belief was that online support only had disadvantages compared to face-to-face. However, we anticipated that the use of online support in MLSCs would have some advantages for students and practitioners compared to a normal face-to-face interaction. It is also possible that there may be disadvantages that were not expected. We aimed to assess these from the practitioners' perspective.

RQ7: What plans do the MLSCs have for the future when there are no COVID-related restrictions on ways of delivering MSS?

Given how higher education responded to the pandemic restrictions, it seems unlikely that in a post-pandemic world, with no COVID-related restrictions, things will go back to how they were before. Similarly, within the narrower field of MSS, we expected that the experiences MLSCs have had in giving online support to students would have influenced their plans for delivering services in future (when the pandemic situation is over). Therefore, we asked what (online) services will continue in the future or if the MLSCs expect to return to solely face-to-face support.

4. Method and sample

To examine the research questions mentioned above, the authors collaboratively developed the questions for the survey. The authors' team includes colleagues from a British university and a German university who have substantial experience in mathematics education research and in providing mathematics and statistics support. Items and questions were evolved either in English or German, translated by the team, discussed, reworded and finally translated again. The survey consisted of 32 items (open and closed format questions) in the English version for GBI and three additional items in the German version gathering more information about the respondents. The survey was conducted online in both countries using appropriate software in GBI (www.onlinesurveys.ac.uk) and in Germany (www.unipark.de). The calls to participate were distributed via e-mail, based on self-registered lists of MLSC practitioners. In Germany, the newly established network of German MLSCs was used to call for participants. The call could also be forwarded to MLSCs tutors outside this network. For GBI, the longer-established sigma-network Jiscmail list was used to distribute the call.

The survey was conducted during April in Germany (7 April 2021–30 April 21) and from May to July in GBI (21 May 2021–9 July 21). In GBI, a survey had been undertaken in the early stages of the pandemic, in May 2020. It was agreed that it would be sensible to allow a whole year to pass before issuing the survey that is the subject of this study. Furthermore, it was anticipated that, because of the timing of the academic year in GBI, June and early July are times when MLSC practitioners are more likely to be willing to respond to a survey, since the high demand period of before examinations will have passed.

Because the academic years in GBI and Germany do not exactly synchronize, it was felt that April was a more likely time to gather responses from German practitioners. Although times of rapid change have been a feature of the response to the pandemic, this period (April to July 2021) was a relatively stable time and so we anticipate that the difference in time when practitioners in the two locations completed the questionnaire will have no significant impact on the responses.

Where appropriate, thematic analysis was used to group qualitative data into shared ideas following the method described by Thomas (2006). Responses to questions with an open text response were collated into one place, reformatting if necessary, and read repeatedly. Colour codes were used to identify the main idea(s) within each response and the process repeated until responses would be linked together and condensed into categories. Responses could belong to more than one category if practitioners gave multiple key ideas in their response.

4.1. Responses

In Germany, 47 participants from 20 universities answered the survey, with an average experience in MLSC of 3.7 years (range: 0.5–20). Nineteen participants were managers of MLSC (responsible for leadership of MLSC tutors and employees), but almost all participants (41) were involved in giving support to students in MLSCs (i.e. they were not solely managers).

From GBI, 35 participants from 24 universities (England 17, Scotland 3, Ireland 3, Wales 1) took part in the survey. The institutions they represented have been providing MSS for an average of 14.5 years (range: 2–33). In Germany, 10 participants did not provide any answers to the questions relating to face-to-face provision. In GBI, there were two such respondents and one respondent who did not provide any answers to the questions relating to online provision.

5. Results

RQ1: During the pandemic and the partial lock down of universities, what kind of mathematics and statistics support was provided by MLSCs to students?

To first gauge an idea of how support provisions differ between the two locations, if at all, practitioners were asked what methods of support, both online and in person, their institutions offered between October 2020 and February 2021. Figure 1 shows this comparison. Unsurprisingly online support was much more frequently offered than in person support.

The most common service offered in GBI was pre-booked online appointments (91.2%), whereas only 17% of German practitioners provided this, their least offered support method. However, online drop-in sessions were offered by over 60% in both GBI and Germany. This was the most frequently offered support method by German practitioners and the second most common by practitioners in GBI.

Additionally, Germany's second most supplied provision was the offer of online open learning spaces (63.8%), provided by only a very small number (11.8%) of practitioners in GBI. There was also a large difference in the offering of this provision face-to-face, where almost one-third of German participants reported making face-to-face learning spaces available to students.

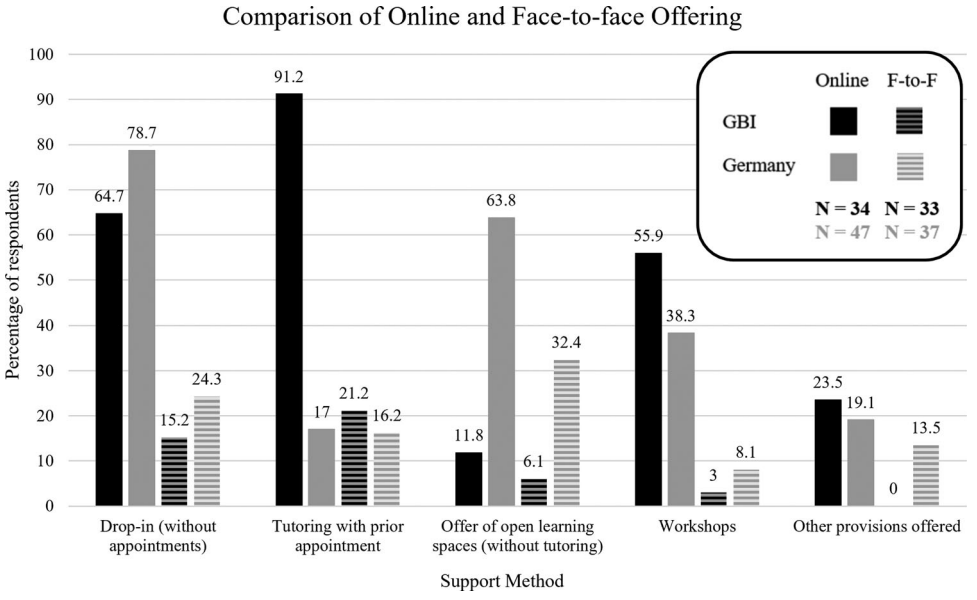

Figure 1. Comparison of online and face-to-face offering Oct 2020–Feb 2021.

In both locations, around one-fifth of participants reported offering some 'other' service. In GBI, these other services included online resources, email support and study group sessions, whilst, in Germany, learning videos, interactive exercises and partnering students for exam preparation were mentioned. No 'other' face-to-face services were reported in GBI, but in Germany 13.5% selected this option with lending of materials, such as books and learning resources, and bridging courses being the support mentioned.

The majority of institutions in both locations did not offer any face-to-face support during October 2020 to February 2021. If we infer that those who provided no answer when questioned what face-to-face provisions they offered during this period (2 in GBI and 10 in Germany) had no such provision and add these to the respondents who explicitly stated that they had no such provision, we find that 74.3% of GBI respondents and 61.7% of German respondents were at institutions with no face-to-face MSS during this period.

RQ2: From practitioners' perspectives, how did the level of use of support change from before to during the pandemic situation?

To understand changes in student engagement over the duration of the global pandemic, practitioners were asked to compare engagement levels during October 2020 – February 2021 to before the pandemic (October 2019 – February 2020), and to the initial period of the pandemic (April 2020 – Sep 2020). These are shown on the left and right, respectively, in Figure 2. Although the length of these time periods was different, the question was not exploring the total number of students who made use of MSS during these periods but rather the level of usage ('busy-ness') when MSS was available.

Overall, over half the responses received in both locations stated that support was used less or much less during October 2020 – February 2021 when compared to before the pandemic, when face-to-face services were mainly offered (61.8% of 34 GBI practitioners and 51% of 47 German practitioners). However, both locations reported seeing an increase in

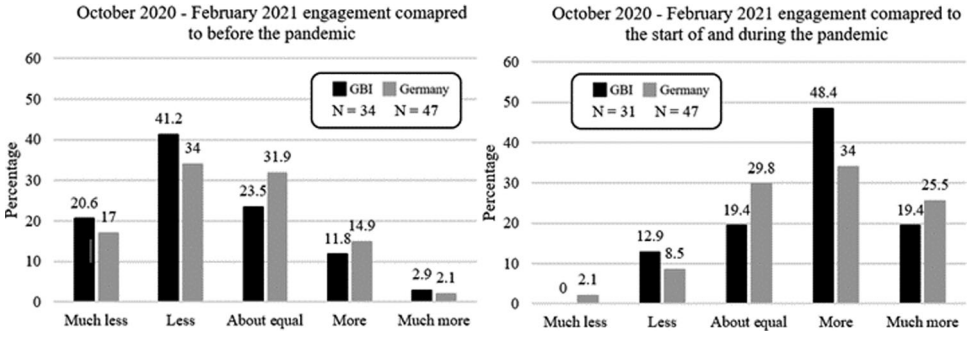

Figure 2. Comparison of use in Oct 2020–Feb 2021 to Oct 2019–Feb 2020 (before the pandemic; left) and to April 2020–Sep 2020 (the initial period of the pandemic; right).

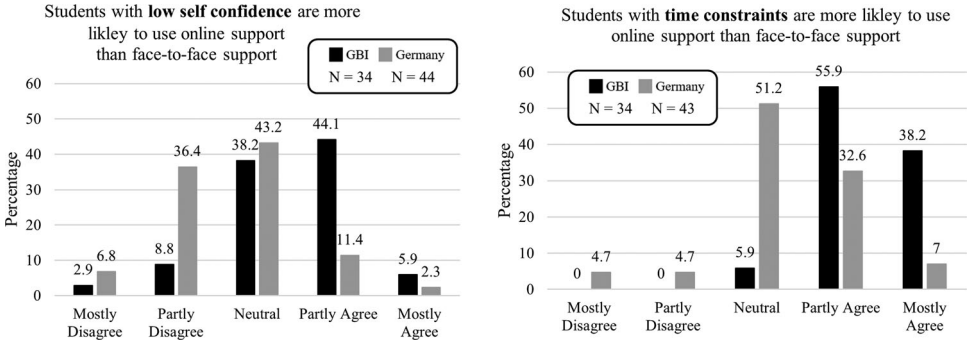

Figure 3. Comparison of use: characterizing students with online usage.

engagement in October 2020 to February 2021 compared to during the initial period of the pandemic. 67.8% of GBI practitioners and 59.5% of German practitioners thought that support was now being utilized more or much more by students.

In order to explore potential reasons for any change in engagement due to the pandemic, practitioners' opinions on student preferences were also explored. They were asked their level of agreement with two statements: students with low self-confidence are more likely to use online support than in person support (see Figure 3 left), and students with time constraints are more likely to use online support than in person support (see Figure 3 right). These options were chosen as these two characteristics were identified in Hodds (2020a) as aspects of online support practitioners considered to be better than face-to-face, which we wanted to explore further.

Practitioners from both locations were in agreement that students with time constraints are more likely to use online support than face-to-face provisions. No practitioners in GBI and only 4 out of 43 German practitioners partly or mostly disagreed with this statement (Figure 3, right).

On the other hand, opinion was divided over whether students with low self-confidence are more likely to use online support than face-to-face support. In Germany, opinion skewed to the left, with 43.2% disagreeing to some extent compared with 13.7% agreeing to some extent, suggesting that German practitioners do not believe students with low

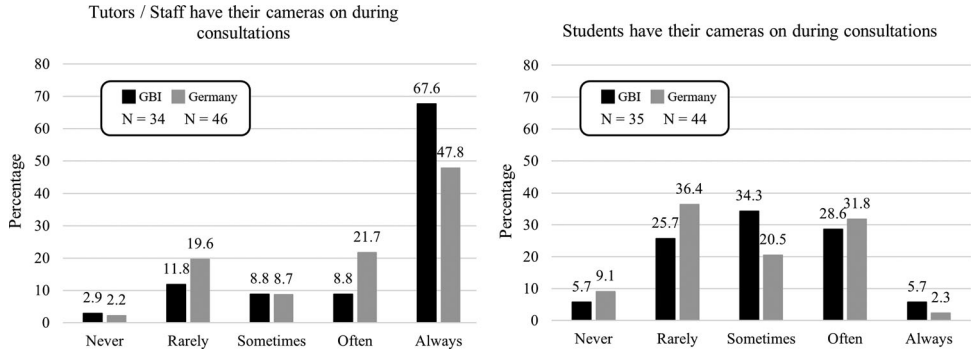

Figure 4. Comparison of camera use in consultations between tutors and students.

self-confidence utilize online support more than face-to-face. However, the most common response was a neutral opinion, neither agreeing nor disagreeing with the statement, with 43.2% choosing this response. Whereas, for GBI, there was strong agreement (50%) and very low disagreement (11.7%), with a substantial group of participants (38.2%) being neutral. Opinion was markedly skewed to the right, showing practitioners did feel that low self-confidence students prefer to use online support.

RQ3: What types of tutor/student and student/student interactions take place in online support?

The majority of practitioners interviewed in the study of Gilbert et al. (2021) reported that it was a common occurrence for students to not turn their cameras on during online support. A range of reasons were given for this: students' own preference, issues with technology or the institution not requiring cameras to be on. Although participants in that study were from around the world (with the majority from the United Kingdom) there were no participants from Germany. Hence, in the present study, it was important to see if this phenomenon also occurred in Germany. As a point of comparison, shown in Figure 4, we also asked practitioners whether the tutors / staff in their institutions kept their cameras on during consultations.

In GBI, 67.6% of respondents stated tutors or staff always have their cameras on during consultations, compared to only 5.7% of students. Likewise, a large difference was also found in Germany, 47.8% tutors / staff to 2.3% of students always having their cameras on. Most practitioners in both locations (65.7% GBI, 66% Germany) said students sometimes, rarely, or never have their cameras on.

As a result of students' limited camera use, interaction between tutor and students is more difficult. Gilbert et al. (2021) reported this as the largest disadvantage to online support in practitioners' opinions. A particular difficulty faced was the lack of verbal cues making it difficult to determine whether students are engaged and understand the content. Furthermore, a key service provided in pre-pandemic times was the use of a MLSC as a place for students to collaborate with their peers, often without any input from tutors. It seemed likely that this is something that would be affected by the move to online MSS. So, we explored these issues with practitioners; the results are shown in Figure 5.

Both locations agree that determining the quality of student engagement remains an issue. Clearly from Figure 5 (left), German practitioners very strongly agree with the

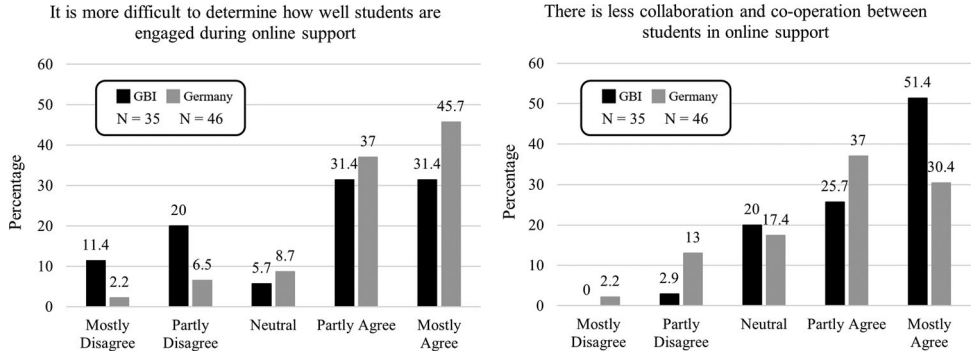

Figure 5. Problems in interactions in online MSS.

statement, with a net agreement (meaning the combined percentage of those who agreed, either partly or mostly) of over 80%, and only 8.7% partly or mostly disagreeing. On the other hand, amongst GBI practitioners, there is more of a split opinion as 62.8% of practitioners either partly or mostly agreed, compared to 31.4% net disagreement.

Practitioners were also questioned about collaboration and co-operation between students in online support (Figure 5, right). This time, both locations are in strong agreement with the statement that there is less collaboration between students in online support. Net agreement amongst German practitioners was 67.4%, with partly agree being the modal response; amongst GBI participants net agreement was 77.1% with mostly agree being modal. The differences here between the two locations are consistent with the information in Figure 1 where 63.8% of German respondents reported offering open learning spaces online compared with only 11.8% of GBI respondents. It seems clear that opportunities for online collaboration were much more restricted in GBI than they were in Germany.

RQ4: How effective has advertising online MSS been?

It is well-known that the pandemic forced all areas of university life (academic and social) online and, during the periods of full lockdown, all information had to be distributed digitally. Hodds (2020a) identified two major concerns relating to advertising MSS services as a result. Firstly, prior to the pandemic, word of mouth, both students discussing their support experiences with their peers and lecturers informing their students of services, had been an effective form of publicizing MSS. It seemed likely that the pandemic would impede its effectiveness. Secondly, concerns had been expressed about email overload: the significant increase of email information about all aspects of academic life causing students to be selective in the emails they paid attention to and possibly meaning that advertising of support services was overlooked. We wanted to explore whether practitioners still felt that these issues were as prominent.

As shown in Figure 6 (left), the most common response from practitioners to the statement: word of mouth is less effective than it was prior to the pandemic, was partly agree, with both over 40% and only a 0.8% difference between locations. Over half of all practitioners either partly or mostly agreed, with 58.8% of 34 GBI responses and 65.9% of 47 German responses. A similar result can be seen in Figure 6 (right) when practitioners were asked whether emails regarding support were being overlooked due to the excess

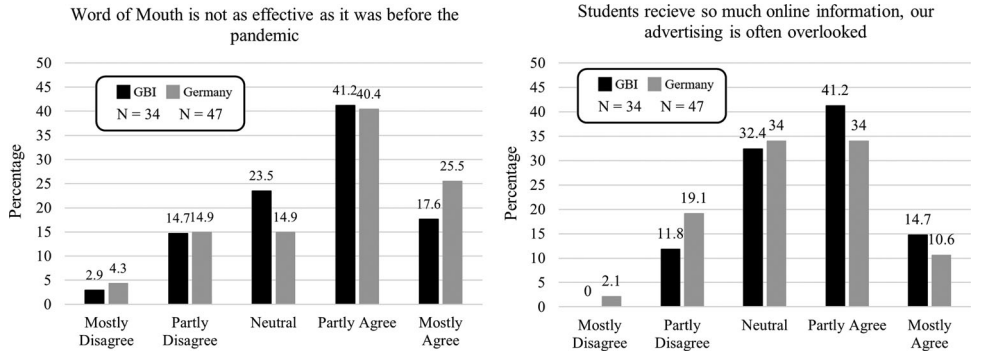

Figure 6. Changes in MLSCs advertising.

Table 1. Change in opinions of online support.

	%	
Group	GBI	*G*
Positive change in opinion for online support – their opinion has changed to become more positive	65.5	51.3
Negative change in opinion for online support – their opinion has become worse	0	5.1
No change in opinion – they feel the same now as they did before the pandemic (positive or negative)	20.7	23.1

of online information; partly agree was again the most common response and 55.9% of GBI responses and 44.6% of German responses indicated a level of agreement. The information in these two graphs suggest strongly that traditional means of advertising MSS are not effective in the online environment.

RQ5: How did practitioners' views change over time?

At the time this survey took place, institutions had experienced a year of online support provision. At the end of the survey, we asked three questions, the first of which explored how practitioner opinions have changed over the space of the year. Responses fell into the three groups shown in Table 1.

The question received 29 and 39 responses from GBI and German practitioners respectively. The percentages in Table 1 represent the number of responses that mentioned a positive, negative or zero change in opinion of online support since the beginning of the pandemic. It is important to note that the percentages do not add up to 100 because the question also received answers that did not discuss a change in opinion, rather just positive or negative comments regarding online support, and have therefore not been included in the analysis.

The most common response was that practitioners were now more positive than they were prior to the pandemic; 65.5% and 51.3% of GBI and German responses respectfully. A common theme amongst German practitioners was being pleasantly surprised at how much could be achieved online; for example, '*the* [my] *view of the* [technical] *possibilities has expanded*' and '*it* [the online support] *was better than expected*' and practitioners were '*positively surprised how well it* [the online support] *worked*'. GBI responses contained phrases such as '*gained a greater understanding*' and '*more in favour of online support now*'.

Table 2. Practitioners opinions of benefits and disadvantages of online support.

	%			%	
Benefits	GBI	*G*	Disadvantages	GBI	*G*
Flexibility and accessibility	48.0	72.2	Interaction and collaboration challenges	47.4	51.7
Time saving	24.0	12.1	Difficulty of online support	15.8	31
Convenience	20.0	12.1	Less personal	0	24.1
Anonymity and intimacy	16.0	9.1	Time consuming	21.1	13.8
OTHER (mentioned by single practitioners)	12.0	3.0	Engagement and Proactiveness	21.1	10.3
	(4% each)		Lack of spontaneity	0	6.9
			OTHER (mentioned by single practitioners)	21.1	6.9
				(5.28% each)	(3.45% each)

In GBI, 20.7% of the practitioners stated that their opinion of online support had not changed, half of which were practitioners who stated they had supported or were preparing to support students online prior to the pandemic. In Germany, 23.1% of the practitioners also stated no change. Additionally, the German survey also received two respondents stating their opinion of online support had declined since the beginning of the pandemic.

RQ6: What benefits or disadvantages do practitioners see in online support?

The final two questions asked practitioners for any advantages or disadvantages to online support that had not been previously mentioned in the survey, and responses were grouped into common ideas across both locations (Table 2). The percentages in Table 2 represent how many responses mentioned a specific advantage or disadvantage. Some responses fell into more than one group as some practitioners discussed multiple points, hence the percentages do not add up to 100.

The advantages questions received 25 responses from GBI practitioners, and 33 from German practitioners, with the most mentioned advantages in both locations being flexibility and accessibility, 48% and 72.7% respectfully. It was commonly thought that online support not being confined to a particular physical location is a benefit, as staff and students do not have to travel. This is particularly beneficial for those who find this difficult, for example students with a disability or home life commitments such as childcare. This also means online support can be offered at more times, allowing for the support to be adaptable around individual student's schedules.

The second most identified benefit in GBI was online support saving time, mentioned by 24% of practitioners, with particular reference to when students miss sessions. Without a physical location to commute to, travelling time is no longer required and if the student does not arrive, the tutor is no longer forced to sit in a room waiting to result in a wasted journey. Although also the second most identified benefit from practitioners in Germany, this was not as important, with only 12.1% giving responses relating to saving time as a benefit, mainly referring to saved travelling time.

Convenience of online support was also mentioned by 12.1% of German practitioners. Two responses described the ease of accessing online support methods, where the lecture

course can be trialled by students just by clicking on a course link. The other two reasons given were about the efficiency of storing and distributing resources. In GBI, 20% of the practitioners also stated convenience as an advantage, namely again the sharing of digital content such as presentations and collaborative notes made during a session, all of which can be stored in one location for easier access. In addition, 16% of GBI and 9.1% of the German practitioners mentioned online support having more anonymity and intimacy as a benefit because of the quieter, less distracting environment online support creates.

Finally, there were other benefits in both locations mentioned by a single practitioner. For GBI these were: the ability for tutors to save face by checking their knowledge without the student's awareness, students coming to support more prepared and focused in an online setting and online support presenting a better environment for nurturing ideas. For Germany, this was that in an online setting, tutors have a better overview of the students who want support (for example in a zoom-session they can easily raise a hand or write in the chat even if the tutor is busy).

Difficulties with interaction were identified as the largest disadvantage by practitioners from both locations, 47.4% of 19 GBI responses, and 51.7% of 29 responses in Germany. Group work and the challenge of collaboration and interaction between students was particularly mentioned in responses, as well as the lack of social interaction and informality that comes with face-to-face interaction.

As with the advantages question, the second largest concern for GBI practitioners was the effect on time. Online support was more time consuming according to 21.1% of respondents, specifically having to allow more time for technological problems, such as internet quality creating a delay or the inexperienced use of new software causing teething problems. The transition to online also introduced additional considerations that were not required before, for example closed caption editing of video recordings. More time wasted was also a concern to 13.8% of German practitioners, referring to the running of online support taking longer.

Finding difficulty with areas of online support was identified as the second most important disadvantage to German practitioners, mentioned by 31%. In GBI, 15.8% of the practitioners also mentioned difficulty. The majority of reasons given related to the challenge of recreating elements of in person support in an online setting. German practitioners gave examples such as networking, handling many students simultaneously and written communication and both locations discussed the difficulty of gaining an idea of how successful their support provisions are. Other German responses were about the use of online support itself, namely requiring multiple software and needing additional technical skills. This was closely followed by 24.1% of German responses stating online support was less personal; how a less-relaxed environment can make it a challenge to help a student on a one-to-one level.

Further, 21.1% of GBI responses and 10.3% of German responses stated that student engagement was reduced, and students need a higher level of proactiveness to access online support. They can no longer just see a physical centre and spontaneously choose to walk in, they must actively decide they need additional support and then know where and how to access it or make the effort to acquire this information. It was also mentioned in both locations that it is easier for students to not engage when using support, for example asking questions.

Other disadvantages that were suggested by single practitioners in GBI were the challenge of maintaining both online support alongside face-to-face provision, the low ability of students to discern quality of resources resulting in practitioners having to supply more, preferring face-to-face support, and technological issues. For Germany, two practitioners mentioned the lack of spontaneity online support causes, and single practitioners talked about students needing a change of location to facilitate learning, and online support being more repetitious.

RQ7: What plans do the MLSCs have for the future when there are no COVID-related restrictions on ways of delivering MSS?

Prior to the final questions on the survey, practitioners were questioned on their plans going forward once restrictions were lifted and a return to face-to-face provision was possible (Figure 7). 'Online workshops' was only available as an option on the Germany survey, as was 'other' on GBI survey. The questions were presented in the survey software in slightly different ways. In the German version, respondents were asked to respond 'Yes' or 'No' to each option whilst in GBI version, respondents were presented with a list and could only select one option. The first option was *return to a fully face-to-face offer (without any online tutoring)*. This was intended to be mutually exclusive to *offer online tutoring alongside face-to-face provision* and *offer online support only*. Hence a list where only one option could be selected was appropriate. However, the additional option *provide online workshops* on the German survey was not mutually exclusive with some of the other options and hence the separate 'Yes/No' responses were used. This did lead to some seemingly inconsistent responses with some participants answering 'Yes' to *return to a fully face-to-face offer (without any online tutoring)* and then also answering 'Yes' to one of the other options which included some online support. This is a limitation to the design of the questionnaires, and the potential for mutually exclusive misinterpretations may have been identified and prevented by piloting the surveys and making necessary changes.

GBI practitioners were almost unanimous is maintaining some form of online support alongside face-to-face provision with 94.3% indicating their intention to offer online tutoring alongside face-to-face support, with an additional 2.9% intending to continue with online support only. The final participant (2.9%) stated other and explained this meant that a decision had not yet been made. No GBI practitioner was planning a return to a solely face-to-face approach.

Conversely, there were split opinions from the German practitioners. About 50% of practitioners stated they were planning to return to a fully face-to-face service when the pandemic is over and 60.9% plan to offer online support in addition to face-to-face support. As stated earlier, in the German survey multiple answers were possible, hence there were 10.9% who chose both answer categories. This could be interpreted in two possible ways. The first was that these practitioners were unsure about the kind of the service which will be provided in the future and think that both could be possible, hence selected both answers. The second is due to the wording of the answer options. 'Return to a fully face-to-face offer (without any online tutoring)' may have been interpreted as going back to what they offered prior to the pandemic, when no online support was offered, and so chose 'offer online tutoring alongside face-to-face provision' to show they would also be offering some online support alongside. Some may have interpreted the latter as online support being the dominant form, as it was mentioned in the answer option first, and so chose both options

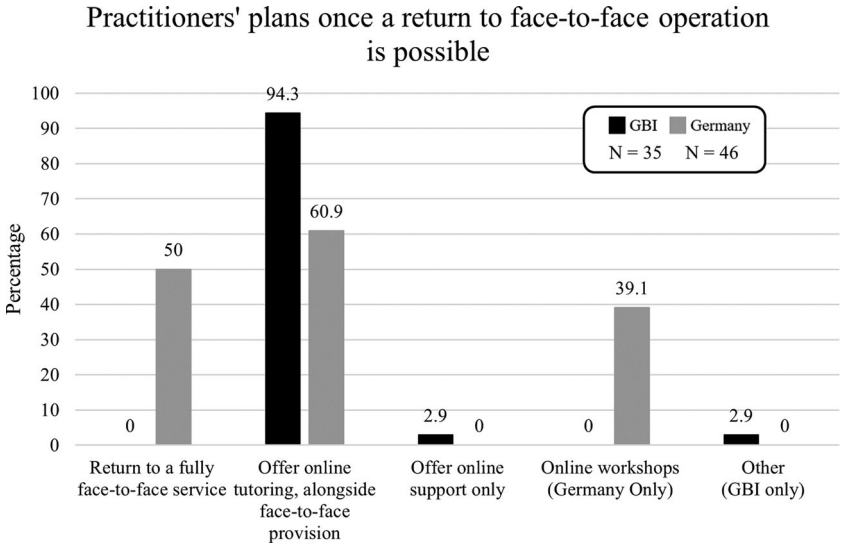

Figure 7. Plans for support service in the future (when pandemic is over). The German survey accepted multiple answers to this question, GBI survey only accepted one.

to imply face-to-face support would return to what was provided before the pandemic, but with a minority of online support in addition.

6. Summary and discussion

In this section, we offer a brief summary of the main findings of this report, incorporating a discussion on potential reasons why similarities and differences were found in both locations. Firstly, a key difference between the two locations was how online systems were utilized. Large numbers of practitioners in both locations offered online drop-in support without appointments (this was the most common provision in Germany and second most common in GBI). As shown in the report by Hodds (2020a), those services that had online provisions in GBI before the pandemic were all drop-in based whereas during the pandemic this had become predominantly an appointment service. Here, we also found that in GBI, pre-booked online appointments were the most common service, however it was rare in Germany, where offering online learning spaces for students to work collaboratively, often without the presence of the tutor in the virtual room, was the second most common service. Although practitioners in GBI did report it would be a nice idea to offer these open learning spaces, it was often felt the technology was lacking to do so. Therefore, it is interesting that in Germany, where support services at most universities are relatively new, these collaborative online spaces were made available. Indeed, in Ireland and Australia, some success has also been seen with open online workspaces for mathematics support (Gilbert et al., 2021; Mac an Bhaird, McGlinchey et al., 2021). This may be due to the technology commonly in use. In the U.K., Microsoft Teams was commonly used as a platform, as reported in Hodds (2020a), rather than Zoom or BigBlueButton, which is where many German practitioners provided the collaborative online spaces. Microsoft Teams initially did not have a breakout room feature, however other potentially less well-known platforms

did have the capability to host such spaces. Furthermore, many institutions in GBI began to use Microsoft Teams for online teaching and learning more generally at the start of the pandemic, so practitioners and learners were more comfortable with using it over other platforms. Alternatively, in Germany there is no tradition for pre-booked appointments in MLSCs, as shown by the survey in Schürmann et al. (2021), so German institutions were perhaps utilizing methods they were more familiar with in providing online support.

It does also appear that about half of the German practitioners are less willing to continue with some form of online support when compared to GBI where virtually all participants stated that hybrid support will be offered from now on. As German institutions offering mathematics support services are not as well established as they are in GBI, it could be that practitioners in Germany feel they do not have the personnel, experience, or the financial resources they need to make hybrid support effective in the future. While in GBI most learning centres have full-time or part-time staff, for example, this is true for only about 12% in Germany (Schürmann et al., 2021). However, it should be noted that responses have come from only those German practitioners who were targeted, so cannot be generalized to all German mathematics support practitioners.

Indeed, the greater experience, particularly with students with additional needs, of practitioners in GBI meant they had specific advantages going into the pandemic over German practitioners. German mathematics support also focuses more narrowly on mathematics rather than statistics. The emphasis is on groups of students working collaboratively who can request occasional help from tutors. This work could be less adequately replicated online than one-to-one consultations. In addition, German mathematics support is often only offered to students from a few degree programmes, who can be well addressed with a fixed location at the university. Furthermore, having used more virtual open spaces as opposed to one-to-one appointments and sessions, German practitioners may not be as aware of some of the benefits of one-to-one online support. It is therefore reasonable that German practitioners are more likely to revert back to the traditional mode of delivery for mathematics support. It should be stated however that British institutions, despite planning to continue with hybrid support, will also predominantly provide face-to-face support over online support (Gilbert et al., 2021).

There were many consistencies reported across the two locations. Both GBI and Germany reported a much-reduced usage of support services in the early stages of the pandemic, consistent with findings and reports from support centres worldwide (Hodds, 2020a), and both are now reporting an increase in usage. A suggestion from German practitioners for the drop in demand is that students in Germany started organizing their learning independently of the universities' platforms, providing a further reason for the lack of engagement from students there. They often use 'Discord', which had become popular in online gaming before the pandemic (Liebendörfer et al., 2022). However, no evidence has been provided to suggest that something similar happened with students in GBI. There was also consistency in beliefs around which students benefit most from the availability of online support, namely students who have time constraints. This may be due to family reasons, part-time learning, or placement timings (e.g. nurses working on wards during the day). As centres move towards a hybrid offering, it will be interesting to see if these students remain using the online services more than the face-to-face.

In this study, the findings show that in both locations the majority of tutors state they have their cameras on whereas students have their cameras off. Online support therefore

seems to provide an opportunity for greater feelings of anonymity, since students may feel less identifiable to a tutor they do not know if they do not have their camera on (even though in most systems, the tutor would see their name). Despite the positive aspect of engaging with more students who would usually remain away from physical support services, there is a significant downside to this. As has been previous reported, without cameras being on you cannot 'see the whites of [the student's] eyes' (Gilbert et al., 2021, p. 309) and therefore the service being offered may not be as useful for the student as it would be in person. Facial expressions and body language are useful for offering the best support, and teaching more generally, to students. In face-to-face situations, students can convey their confusion without actually saying they do not understand and get the support they need. Conversely, in online situations they would need to actually state they do not understand in front of everyone in attendance, which perhaps may be embarrassing for them. Perhaps this therefore partly explains why it has been reported that students learning mathematics online during the pandemic have found it challenging, preferring the traditional face-to-face method (Golding, 2021).

To attract students to engage with a service, advertising is key. Both locations felt that the traditional word-of-mouth method was not as effective during the pandemic, which is perhaps intuitively obvious. Therefore, this may explain why reduced numbers were seen initially. What still needs to be resolved is how best to change this and advertise services better to students. It has been suggested that e-mails are not the preferred route as students have felt overwhelmed by them throughout the pandemic (Hodds, 2020a), so an alternative should be considered that is as effective as word-of-mouth but whilst working remotely. More research into the student view will perhaps provide this.

Finally, papers emerging from GBI are now reporting the effects of the pandemic on younger student learning; those that will be entering university from 2021 onwards. These papers are showing that students will be underprepared and be less confident with their mathematical skills than ever before (e.g. Golding, 2021; Redmond et al., 2021). One paper from Germany suggests there may even be differences in skills and attainment of students according to where in the country they have come from (Schult et al., 2021). If so, institutions in both locations that offer mathematics support will need to carefully consider how best to support these students using the methods, skills, and tools learnt during the pandemic.

We intend to take the learning from this scoping study into further research to explore some of these issues in greater depth by conducting focus groups with students from a small number of institutions to identify (dis-) advantages of online mathematics support regarding the use of different software and support concepts. The results will allow us to compare the student experiences with the broader findings from the practitioner questionnaire reported here.

Notes

1. WiGeMath project (Wirkung und Gelingensbedingungen vonUnterstützungsmaßnahmen für mathematikbezogenes Lernen in der Studieneingangsphase; Effects and success conditions of mathematics learning support in the introductory study phase).
2. At the time of the call for participants to this study, the fledgling network did not have a name, but consisted of 41 members from 26 universities. It has since been agreed to call this network LemMa which is an abbreviation for the German phrase Mathematik Lernzentrum (mathematic learning centre; www.lemma-netzwerk.de).

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

1. Name of Institution:
2. To which of the following target groups of students are the services offered in your learning centre addressed (choose all that apply)?
   - Students on Mathematics degrees (BA/MA)
   - Students from teacher education
   - Students from engineering courses
   - Students from other degree programmes
3. (Approximately) When was the maths learning centre at your university established (Year)?
4. What forms of online support have you offered from October 2020–February 2021 (choose all that apply)?
   - Drop-in (i.e. without appointments)
   - Tutoring with prior appointment
   - Offer of open learning spaces (without tutoring)
   - Workshops
   - Other
   - For 'Tutoring with prior appointment', do students indicate the topic they want assistance with?
     - Yes
     - No
   - If Yours truly, selected Other, please specify:
5. What forms of face-to-face support have you offered from October 2020 – February 2021 (choose all that apply)?
   - Drop-in (i.e. without appointments)
   - Tutoring with prior appointment
   - Offer of open learning spaces (without tutoring)
   - Workshops
   - Other
   - No face-to-face support was available [GBI ONLY]

- For 'Tutoring with prior appointment', do students indicate the topic they want assistance with?
  - Yes
  - No
- If you selected Other, please specify:

6. Overall, the Maths learning centre's services were used by students in October 2020–February 2021 compared to the before the pandemic (October 2019–February 2020):

	Much less	Less	About equal	More	Much more
Choose which applies					

7. Overall, the Maths learning centre's services were used by students in October 2020–February 2021 compared to the last summer (April 2020–September 2020):

	Much less	Less	About equal	More	Much more
Choose which applies					

8. Students with low self-confidence are more likely to use online support in maths learning centres than face-to-face support

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

9. Students with time constraints (e.g. children, part-time) are more likely to use online support in maths learning centres than face-to-face support

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

10. I think that word-of-mouth advertising about our learning centre is not as effective as it was before the pandemic

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

11. I think that students in the pandemic receive so much online information that our advertising is often overlooked

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

12. Providing maths (not statistics) support online is particularly challenging because of mathematical notation

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

13. Providing maths support online is particularly challenging because of technical problems

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

14. Providing maths support online is particularly challenging because of lack of student equipment (tablets and pens, camera, microphone; internet connection)

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

15. The ability of students to use digital media in the online learning centre is low

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

16. The ability of staff to use digital media in the online learning centre is low

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

17. Tutors or staff of our maths learning centre have the camera on during consultations

	Never	Rarely	Sometimes	Often	Always
Select that applies					

18. Students have the camera on during consultations

	Never	Rarely	Sometimes	Often	Always
Select that applies					

19. Online it is more difficult to determine how much students are engaging with the support provided

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

20. There is less cooperation and collaboration between students in an online maths learning centre than in an on-site in maths learning centre

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

21. Staff or tutors have to make more effort online than on-site to provide effective guidance

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

22. Students have to make more effort to learn online than on-site

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

23. Students have had greater non-academic burdens during the pandemic

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

24. Students have had less time or energy for study during the pandemic

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

25. The same interactions between students and staff or tutors take more time online than on site

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

26. For us as a maths learning centre team, online implementation has freed up time for other activities (better preparation of consultations, planning for the future, etc.)

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

27. The online operation of the maths learning centre has increased the time burden on staff or tutors

	Mostly Disagree	Partly Disagree	Neutral	Partly Agree	Mostly Agree
How far do you agree?					

28. [GBI ONLY]
Once a return to face-to-face operation is possible, our maths learning centre will:
- Return to a fully face-to-face offer (without any online tutoring)
- Continue to offer online tutoring, alongside face-to-face provision
- Offer only online tutoring
- Other

28a. If you selected Other, please specify:
[GERMANY ONLY]
Participants were asked to respond Yes or No to each of the following:

Once a return to face-to-face operation is possible:
- We plan to return to a fully face-to-face offer (without any online tutoring)
- We will continue to offer online tutoring, alongside face-to-face provision
- We will only offer online tutoring
- We also plan to offer workshops online
- Other (open question format)

29. How far has your attitude towards online support in the maths learning centre changed in the last year?
30. What benefits of online support in the maths learning centre do you see that have not yet been mentioned above?
31. What disadvantages of online support in the maths learning centre do you see that have not yet been mentioned above?
32. Do you have any other comments relating to online maths support?

The following are the additional questions on the German survey translated into English:

Questions about the person

Academic qualification (degree)

1. Please indicate the highest degree of your academic qualification:
- Abitur (or comparable)
- Bachelor's degree (or comparable)
- Master (or comparable)
- Doctorate
- Habilitation

Type of position

2. Which tasks and functions do you assume within the framework of the learning centre (multiple answers possible):
   - Giving support to students
   - Planning and organizing
   - Managing and leading tutors or staff members

Work experience in a learning centre

3. How many years of experience (as tutor or staff member) have you had in learning centres?