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Mathematics Lecturers' Views on the Student Experience of Emergency Remote Teaching Due to COVID-19

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Abstract: Due to the COVID-19 pandemic, university closures were commonplace worldwide from March 2020, meaning that lecturers and students had to adapt to emergency remote teaching with little or no notice. In this paper, we report upon the results of an online survey undertaken with university mathematics lecturers during May–June 2020. There were 257 respondents from 29 countries who gave their reactions to emergency remote teaching due to the COVID-19 pandemic. Here, we focus upon lecturers' perceptions of how their students coped with this style of teaching, considering any particular difficulties they reported to their lecturers, their attendance at online teaching sessions, and their engagement in a general way. Lecturers reported students struggling with both hardware and software issues, particularly in relation to fast, reliable broadband. Childcare issues also emerged as a challenge for students during this timeframe, as well as students' personal circumstances in terms of living situations and financial stability. Overall, lecturers reported lower levels of engagement with online learning compared to in-person lectures, which occurred prior to the pandemic. However, four-fifths of respondents were still in regular contact with their students during this time. Many of the studies exploring the impact of COVID-19 on the teaching and learning of mathematics in higher education are small-scale, sometimes single-module studies. Restrictions differed greatly between countries, and indeed between regions, meaning that the results of any regional study cannot be generalised to a more international experience. In addition, the experience of students studying mathematics as their degree programme differed from those who undertook only one mathematics module as part of a science, engineering, or business degree. This paper provides a more global insight into the student experience during the COVID-19 pandemic. By focusing on lecturers, rather than asking students directly, the experiences of those students who may not have engaged with such a study have been included; oftentimes, these students were those who struggled the most with this new format of learning.

Keywords: online; remote; experience; COVID-19; mathematics

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1. Introduction

The spread of the COVID-19 pandemic meant a sudden move to "emergency remote teaching" [1] for university students around March 2020 for the remainder of the university semester. Teaching and learning mathematics online presents a number of challenges [2], many of which were exacerbated by the lack of time for planning and preparation in this case [3]. Studies are beginning to emerge investigating the student experience. Two such studies are Hyland and O'Shea's study with mathematics students in higher education in Ireland [4] and Naidoo's study on postgraduate mathematics education students in South Africa [5]. It is difficult, however, to gather data from a wide variety of students across numerous universities and countries. There is the added challenge of engaging struggling students with a study of this kind.

The research reported in this paper forms part of a larger study into mathematics lecturers' experience of remote teaching during the COVID-19 pandemic. One feature of

this study was to investigate the student experience from the lecturers' perspective. Many lecturers had contact with a large number of students from a range of backgrounds. Their exposure to the issues that students brought to their attention allowed them to reflect on the student experience. In addition, this qualified them to provide feedback on the levels of engagement by the general student body. It is necessary to consider these challenges in order to evaluate the effectiveness of the teaching and learning that took place during this time. Thus, the aim of this paper is to address the following research questions:

1. Did students disclose to their mathematics lecturers' difficulties accessing materials due to issues with broadband, hardware, software, personal reasons, or learning difficulties/disabilities?
2. Do mathematics lecturers perceive that students attended online teaching sessions as frequently as their usual in-person classes?
3. Did mathematics lecturers have any regular form of engagement with their students during this time?

In an attempt to address our research questions, we developed an online survey for mathematics lecturers in higher education. Details of its development and analysis are described below. When considering these research questions, a range of different background areas also need to be taken into consideration. A brief overview of the relevant literature in these areas is presented below.

1.1. Issues with Equipment Access

With the move to emergency remote teaching, universities and lecturers scrambled to continue to educate their students. However, despite their best efforts, a range of student difficulties meant that for some, accessing materials and engaging with online teaching proved to be challenging. Hyland and O'Shea surveyed 263 undergraduate mathematics students from six universities in Ireland [4]. They found that more than a third of students reported not having access to "fast and reliable" broadband, and a similar number did not have a PC or laptop. Considering that this was an online survey, it is likely that the problem was even more widespread than this. Similar problems with technology have been echoed in studies involving university students in a wide range of other countries, including Australia [6], Ghana [7], Indonesia [8], Malaysia [9], and the USA [10].

1.2. Learning Difficulties

Students with learning difficulties or disabilities can encounter additional obstacles when studying mathematics, both in-person and, particularly, online, due to the symbolic nature of the subject [11,12]. A recent study showed a good general awareness of such accessibility barriers among Irish and UK lecturers [13]. However, there are many outstanding issues in relation to the production and interpretation of mathematical symbols in an accessible format online. For example, while screen readers or materials translated into Braille may be provided for students with visual impairments, they are not usually helpful for accessing other information particular to mathematics, such as graphs and diagrams [14,15]. A study in the USA found that 63% of students with a disability encountered unexpected technology costs during the pandemic, compared with 17% of students without a disability [16].

1.3. Increase/Decrease in Attendance

The use of online resources to supplement in-person lectures has become more common in recent years. One recent study of first-year business students in Ireland found that, when given the choice between attending mathematics lectures or watching videos online (or both), the majority opted for the video resources [17]. However, the experience of emergency remote teaching is an entirely different one [1]. Reports of attendance and engagement among the general student body are mixed.

In a small-scale study of 20 lecturers in Bangalore in India, Shenoy, Mehendra, and Vijay [18], it was found that student attendance was up to 20 times better online during

this time period than in regular lectures. Similarly, Gomez, Azadi, and Magid [19] reported that enrolment in their radiology elective increased ten-fold when they moved to online provision. Darici et al. [20] found in their study of 192 s-semester and 200 third-semester medical students that attendance rates (set at a minimum of 85% attendance in order for students to pass) did not suffer from the usual weekend/holiday fluctuation observed for in-person lectures, and recorded median attendance rates of 97.4% and 97.5%, respectively, for the two semesters. On the other hand, Johnson et al. [21] reported "a substantial decrease in attendance and engagement" among the students in their chemistry department. Another study conducted with 270 university students found they self-declared lower levels of attendance and engagement compared with pre-pandemic levels [22].

Hyland and O'Shea [4] found that less interaction and communication emerged as a main theme in terms of challenges reported by mathematics students, with "less communication with lecturer" a minor, but important, sub-theme. Radmer and Goodchild [23] also found that live interaction with lecturers was a concern for mathematics students, with 57.7% of 127 students surveyed agreeing or strongly agreeing. In addition, 77.8% of the 18 mathematics lecturers surveyed reported that they took some moderate or strong action towards mitigating this issue. At the same time, university mathematics support services, which offer students additional one-on-one support with mathematics, have reported dramatic drops in student engagement [24].

1.4. Cost of Studying Online

Soria and Horgos [10] documented the links between social class and students' experience of the COVID-19 pandemic. They found that the gap appears to have widened in terms of the challenges encountered by students of low socio-economic backgrounds. Henaku [7] cited similar findings in the case of university students in Ghana, who described being unable to submit assignments or attend lectures, as they could not afford the internet bundle needed to do so. Similarly, Nassr et al. [9] reported that almost two-thirds of 284 university students surveyed in Malaysia were very concerned about the financial impact of lockdown due to their need to purchase expensive internet data plans. Further reinforcing the link between the educational impact of the pandemic and financial stability, Hussein et al. [25] found that, in their study of university students in the UAE, technology and internet reliability did not feature highly among their difficulties. They attribute this directly to the fact that the UAE is one of the richest countries in the world, where over 98% of households have internet access, and the government arranged free internet packages for those families without during the pandemic.

1.5. Impact on Mental Health

In a study of 30,725 undergraduates and 15,346 graduates in the US, Chirikov et al. [26] found that both major depressive disorder and generalised anxiety disorder were greatly increased in 2020 compared with 2019. Similar findings emerged from a French study of almost 300 university students, where over three-fifths reported experiencing moderate to severe life stress at this time, and a similar proportion reporting increased anxiety [27]. In an Irish context, Hyland and O'Shea [4] found that 62% of 263 students surveyed reported increased anxiety levels.

1.6. Impact on Childcare

This question of childcare responsibilities and whether female students were disproportionately affected by this issue during this time is raised by Crook [28] and Sevilla and Smith [29]. Crook [28] highlights the case of a single parent, studying for a Ph.D., and the struggles she encountered during this time. Sevilla and Smith [29] report that "*Only when comparing women working from home with men in furlough and unemployed do women engage in relatively less additional childcare. Otherwise, women do more of the additional childcare than men, independently of their work status*".

1.7. Importance of This Study

Many of the studies exploring the impact of COVID-19 on the teaching and learning of mathematics in higher education are small-scale, sometimes single-module studies, which explains the discrepancies in some of the findings. Restrictions differed greatly between countries, and, indeed, between regions, meaning that the results of any regional study cannot be generalised to a more international experience. In addition, the experience of students studying mathematics as their degree programme differed from those who undertook only one mathematics module as part of a science, engineering, or business degree. This paper provides a more global insight into the student experience during the COVID-19 pandemic. We report the findings via data attained from lecturers across 29 countries regarding their perceptions of student engagement and access during the move to emergency remote teaching in 2020. By focusing on the lecturers, rather than asking the students directly, we hoped to include the experiences of those students who would not have engaged with such a study; oftentimes these students are those who struggled the most with this new format of learning.

2. Materials and Methods

2.1. Survey Instrument

This study comprises one part of a larger investigation into the remote lecturing of undergraduate and postgraduate students of mathematics during the COVID-19 pandemic. The research methodology adopted for the entire study was quantitative in nature, in order to address our research questions. Our research design comprised the creation and dissemination of a purposely designed survey to a large sample of participants, as this was deemed the most efficient way for us to ask 'specific, narrow questions to obtain measurable and observable data' [30] (p. 14) on the issues we had identified as worthy of investigating, i.e., how lecturers and students were coping with remote mathematics education during the initial stages of the COVID-19 pandemic. In 2020, we created an initial survey in order to investigate how mathematics lecturers were responding to the challenge of a spontaneous move to teaching remotely. In 2021, we completed the investigation with the creation and distribution of a follow-up survey in order to compare remote teaching in 2020 with that in the subsequent academic year.

At the onset of the study, we were interested in the teaching, learning, and assessment trifecta. The initial instrument was designed on that basis. There were seven sections in the survey. One section comprised a series of profiling questions. Another section focussed primarily on the student experience. It is the data pertaining to the student experience section of the survey that is the focus of this paper. We report on the remaining data gathered in [3,31]. The eight questions (five closed, three open-ended—see Appendix A) in this particular section centred on students' ability to access material during the pandemic and the potential challenges they may have faced in this regard, as well as student attendance and engagement. Engagement, in this case, refers to the levels of communication and interaction between students and their lecturers, and not cognitive engagement. The closed questions were written so that respondents could answer yes or no e.g., "Did any of your students let you know that they had difficulty accessing material due to issues with hardware?" Our intention here was to structure questions so that they could be answered without bias. The overall survey was piloted with a panel of experienced mathematics lecturers and amended accordingly. It was anonymous, created in Google Forms, distributed via email mailing lists, and advertised via online mathematics education conferences in May 2020. It should be noted that this occurred during the first university closures, when both lecturers and students were adapting to emergency remote teaching.

The data were analysed using Excel. Statistical analyses of the data failed to show any significant results between any of the variables studied, e.g., country, gender, age, etc., and the various responses given, and so a fully qualitative approach was taken for the analysis. General inductive analysis used to code any qualitative data. General inductive analysis is recognised as an efficient approach to analysing qualitative data [32]. The purpose of

this approach is to 'condense extensive and varied raw text data into a brief, summary format' [33]. We had no preconceived notions about what the findings would be. It was our intention that the theory would emerge from our data, so we sought to use an inductive rather than a deductive methodology. A general inductive approach was, therefore, deemed the most apposite methodology for analysing the data gathered in this study. We followed Thomas' method on the coding process in inductive analysis as our guide for the qualitative data analysis [33]. The raw data were read and re-read by both authors independently. Emerging themes and subthemes were identified by both, and we met to discuss and agree these themes. Subthemes were constructed due to the similarities and differences of the responses within each theme [34]. The data set was revisited independently in order to categorise the data according to the themes and subthemes. We had 82% agreement, which is classed as 'nearly perfect agreement' [35].

2.2. Sample Profile

The results of the profiling questions are shown in Table 1 below. The gender breakdown in the survey was balanced, likely as a result of the survey having been sent directly to a large mailing list for female mathematicians. The vast majority were in permanent employment, and this was reflected in the fact that almost half of all respondents had more than twenty years' experience teaching mathematics in higher education.

Table 1. Profile statistics of survey respondents (n = 257), showing their gender, age, years of experience teaching mathematics in higher education, and current employment status.

	Number	%
Gender		
Male	135	52.5%
Female	118	45.9%
Non-binary	1	0.4%
(Blank)	3	0.8%
Age		
20–29 years	16	6.2%
30–39 years	61	23.7%
40–49 years	69	26.8%
50–59 years	71	27.6%
60 + years	38	14.8%
(Blank)	2	0.8%
Experience teaching maths in higher education		
0–1 year	8	3.1%
2–3 years	13	5.1%
3–5 years	20	7.8%
5–10 years	34	13.2%
10–15 years	31	12.1%
15–20 years	34	13.2%
20 + years	117	45.5%
Employment status		
Ph.D./Postdoc	3	1.2%
Short-term contract (≤1 yr)	16	6.2%
Long-term contract (>1 yr)	28	10.9%
Permanent	205	79.8%
Retired but teaching	4	1.6%
(Blank)	1	0.4%

The highest proportion of respondents were based in Ireland (30.4%), which is where both researchers are also based, with the majority of respondents based in Europe at the time the survey was distributed (93%). In total, respondents from 29 different countries took part in the survey [31].

Although respondents were working in 29 different countries at the time of the survey, the largest proportion by far was based in Ireland, with almost all respondents based in

Europe. Almost three-fifths of respondents were teaching students who were specialising in mathematics, with just over half teaching service-mathematics students (who study some mathematics modules but are not specialising in the subject). In terms of class size, 59.4% had small classes (up to 30 students), 50.4% had medium (30 to 100 students) and 22.7% had large classes (over 100 students). Respondents expected to have a mean of 7.23 contact teaching hours per week before the move to emergency remote teaching, although some had as many as 16 or more. For further details of the sample profile, see [31].

3. Results

3.1. Student Difficulties

In order to address our first research question, respondents were asked if any of their students had let them know that they had difficulty accessing material due to issues with broadband/Wi-Fi, hardware, software, or for personal reasons. Their responses are shown in Table 2 below. It is clear that a significant portion of lecturers were aware of student difficulties under each of these headings, particularly in relation to broadband and personal reasons.

Table 2. Number of respondents who reported knowing that their students had difficulty accessing materials due to issues with various items (some respondents did not answer this question).

	Yes	No
Broadband/Wi-Fi	168	83
Hardware (e.g., no laptop)	98	131
Software (e.g., no access code, difficulty downloading)	71	151
Personal Reasons (e.g., caring commitments, illness etc.)	139	93

In total, there were 142 additional comments under this question, and the comments have been coded into a number of themes and sub-themes, summarised in Figure 1. From the centre, there are arrows leading to the seven themes that emerged from this question: Wi-Fi, hardware, software, and personal reasons, which emerged directly from the question itself, and assessment, frequency of difficulties, and country. Leading from the three latter themes listed, we see arrows directing us to the subthemes that emerged from these themes. The numbers listed alongside each arrow indicates the number of comments within each theme/subtheme.

3.1.1. Poor Wi-Fi

Although poor Wi-Fi was the most common difficulty communicated by students to their lecturers, the comments under this theme were fairly uniform, with respondents simply highlighting the fact that "*connection issues came up pretty much for everyone, including myself*". Some respondents mentioned that broadband service was significantly worse for those students who had gone home to rural locations (*"Rural areas have serious difficulties with access to broadband*"). This was particularly an issue when there were multiple people in the household trying to use the Wi-Fi at the same time ("*not enough Wi-Fi when all work from home*"). Other respondents found workarounds for students such as: turning off their camera during video calls ("*with zoom it works if they did not turn their camera on*"); providing recorded versions of synchronous lectures ("*my Zoom lectures were recorded and sent by mail to those students who had problems with broadband*"); or compressing their video files ("*Some people were only able to download larger videos at night. This got resolved by me by compressing the videos*").

3.1.2. Caring Responsibilities

Primary among personal difficulties were caring responsibilities. Lecturers mentioned the lack of childcare impacting upon students' ability to engage ("*For example, I have a final year project student whose single parent is a nurse, so he is looking after a younger sibling all day*";

"*I have in my class a mother of two young children, there is no childcare at the moment*"), as well as the issues for those caring for sick family members ("*The difficulties were due to illness of . . . family members that they had to care for*"). Students' own illnesses also featured highly under the theme of personal difficulties, with some having contracted COVID-19 ("*A . . . student contracted the virus and then felt unable to complete the module*") and others "*with known mental health issues most obviously hit*." The absence of a safe, quiet space to study was highlighted by a number of lecturers ("*Some students were homeless in shelters with poor Wi-Fi, others had homes they could not concentrate in*"). In addition, respondents mentioned that some of their students had to work more than usual, either due to commitments at home ("*Some students have gone home and now have farm work that prevents them from participating in morning activities*") or because they had frontline jobs ("*Other students were working more than usual in supermarkets etc so had less time to engage in the materials*").

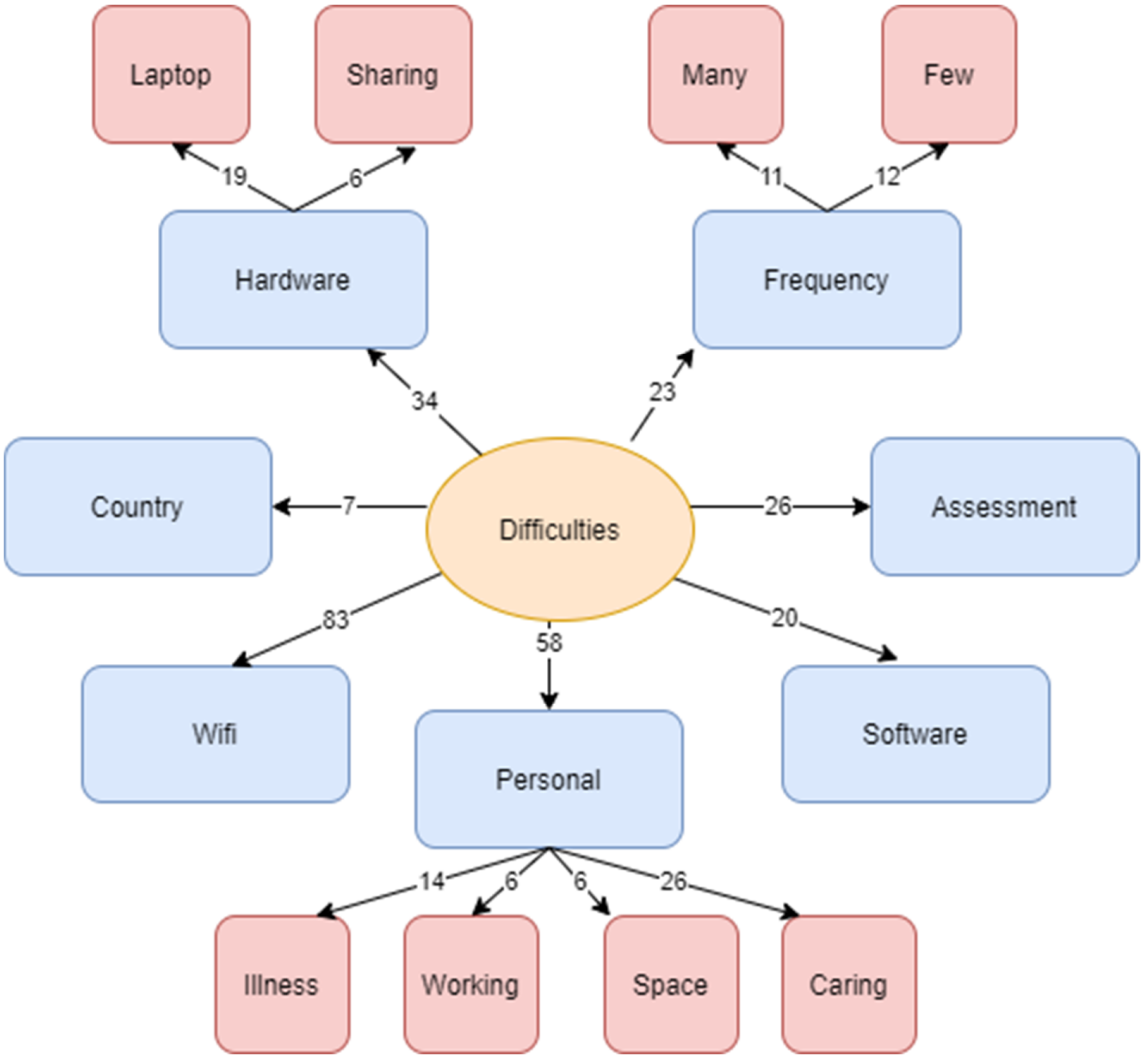

Figure 1. Most common themes emerging from comments made by respondents about difficulties disclosed by students.

3.1.3. Hardware and Software

The lecturers stated that the main hardware issue reported by students to them was either not having a laptop ("*One student was attempting to complete all her work on a smartphone. I sourced a laptop for her*") or their laptop breaking during lockdown ("*One student's laptop broke and there was nowhere to get it fixed or get a new one*"). In other situations, the respondents said that their students were sharing a computer with others in their home, making it

difficult for them to engage at specific times ("*Not every household has enough computers for all family members to work online at the same time*").

Software issues were very specific to the particular software in use in class. Sometimes the issue was due to licencing ("*We didn't have enough online licences for Minitab, given that normally most of the students accessed it physically in the lab*"), while others had installation difficulties ("*Students...either did not manage to complete software installations themselves OR one particular software needed did not have permissions to be installed via vpn*"). Most respondents reported finding alternatives for students ("*For almost all cases, we managed to find a workaround,* e.g., *using MATLAB Online instead of downloading a local copy, use of Virtual Desktop to access other software*"). One respondent observed that "*(m)any students are . . . not technically as savvy with new technology as we sometimes assume*", which resulted in difficulties for some.

3.1.4. Assessment

Assessment emerged as a common theme among the responses. Assessment here encompasses any mention of a summative or formative mode of assessment, where feedback may or may not have been given, that contributed to a student's end of semester grade. Many explained that they were flexible with regard to assessment deadlines in order to take into account issues students might be experiencing ("*Some were directly or indirectly afflicted with COVID, so extensions and accommodations were made*"). Others opted to grant a longer submission time to all students instead ("*I chose to give them days rather than hours to complete assessments*"). In other cases, the approach to assessment was changed to be more suitable to the situation ("*We surveyed them anonymously and all these issues were reported to us. We took this into account in designing our assessment*").

3.1.5. Frequency

Some respondents commented specifically on the frequency of student difficulties they observed, in other words, how often they had students inform them that they needed help with some issue. Almost the same number said that they knew of very few students with difficulties as those who said the opposite. Some of those who observed very few pointed out that the issues were serious for the students in question ("*Relatively small numbers but still significant impact on individual students*"), while others reported that there were "*only one or two problems and we got round these, e.g., delayed upload of test answers or rearranged meeting to suit the student's availability*." On the other hand, there were respondents who stated that "*(a)n awful lot of students had an extremely poor experience this semester*" and "*there is a long list of problems of my students,*" with one respondent sagely observing that "*I suspect there are more I haven't heard about*".

3.1.6. Country

A number of respondents made specific references to difficulties experienced by students who returned to their home country during lockdown. There were several references made to students based in China, due primarily to differences in accessibility of particular online material there. Others mentioned the issue of differing time-zones ("*Different time zones are a real problem, particularly if you are trying to run interactive sessions and you have some students in China and others in North America!*").

3.2. Students with Learning Difficulties/Disabilities/Anxiety

In addition to general student difficulties in the above areas, respondents were asked if any of their students had let them know that they had difficulty accessing material due to learning difficulties or disability. There were 253 responses to this question, and 85.4% said no. 33 respondents provided further comment here. Particular challenges were highlighted for students who were hearing impaired or visually impaired, with three respondents mentioning each. For the former, approaches included adjusting the online format to allow the student to see both the interpreter and the lecture itself ("*he and the*

interpreter managed to work out how to do this eventually"); subtitling pre-recorded sessions; providing one-to-one tutor support; and answering questions via email or Pencast with no audio. For visually impaired students, all assessments were conducted orally. Three respondents also mentioned the challenges for autistic students, observing that they were "*very thrown by the change in routine*" and "*disproportionately affected by circumstances*." A number of respondents mentioned liaising with the disability services in their university, who provided the students directly with support, and some highlighted the provision of extra time in assessments for these students, as per usual for examinations. A couple of respondents recorded their surprise that students had not reported more issues to them, as they are aware of the accessibility challenges that face some students using mathematical software, and raised the concern that they "*fear that the students who may need help did not attempt to study the new material.*" Given that the university closures took place partway through the semester, it is possible that students simply did not engage with material covered after that point.

Although it does not fall under the umbrella of learning difficulties or disabilities, a couple of respondents reported having students with "*high maths anxiety*" or receiving "*(m)any many emails from distressed students*" who had "*psychological problems of various kinds*".

3.3. Student Attendance

In an attempt to answer our second research question, respondents were asked to rank the frequency of student attendance at online teaching sessions in comparison with regular, in-person lectures or tutorials, on a five-point scale from "a lot less frequently" to "a lot more frequently." The results are shown in Table 3 below.

Table 3. Frequency of student attendance at online teaching sessions in comparison with regular lectures/tutorials, as reported by survey respondents (some respondents did not answer this question).

	Number of Respondents
A lot less frequently	56
A little less frequently	52
The same	98
A little more frequently	21
A lot more frequently	5

It can be seen that just under half of respondents (46.5%) felt that attendance was lower online than in person, but 42.2% observed it to be about the same, with the remainder reporting increased attendance at online sessions.

3.4. Engagement with Students

Finally, in order to address our third research question, respondents were asked if they had any regular engagement with students at this time and, of the 250 respondents, 79.6% said that they did. They were then asked about the nature of this engagement: whether it was scheduled/unscheduled, compulsory/optional, and daily or weekly. The responses are shown in Table 4 below.

3.4.1. Scheduled

It can be seen that scheduled, optional, weekly engagement opportunities were the most common types offered, although a considerable proportion also offered unscheduled opportunities. There were 153 comments in response to this question. The most common form of engagement with students was via direct email with lecturers, with 38.6% of comments mentioning this. Some lecturers proactively used email to contact their students ("*Constant emails to students asking for feedback on how they were coping with situation*"), while others used it as a mechanism for students to approach them with queries ("*I encouraged students to email me with any questions arising from the pre-recorded material I made available to them*"). Many also commented that not many students availed of this form of

communication ("*it was a minority (about 20%), but those who engaged, engaged a lot, similar to many ways in terms of who comes up after class etc*").

Table 4. Responses to the type of regular engagement lecturers had with their students during this time (some respondents did not answer this question).

	Yes	No
Scheduled (e.g., at a particular time of day)	153	30
Unscheduled (e.g., at any time of day)	98	56
Compulsory (e.g., all students had to engage for credit)	32	110
Optional (e.g., students could engage as they wished)	164	15
Daily	41	82
Weekly	151	10

3.4.2. Online Classes

The next most common engagement, with 36.6% of comments, was through some form of online class, whether it be a lecture, tutorial, or workshop of some format. Many respondents mentioned running classes at the usual scheduled times ("*All classes & tutorials were delivered during regular timetabled hours*").

3.4.3. Virtual Office Hours

Virtual office hours accounted for 32.7% of comments ("*I had a regular office hour and any student could visit it and ask questions or ask help to solve the exercises*"); most were these were offered online, but some mentioned using the phone instead ("*I have "phone office hours" when any student can call me*"). The formats differed, with some respondents offering typical office hours where students could arrange a one-to-one consultation, and others offering a "drop-in" approach, where any number of students from a particular module could attend ("*I offered Q&A sessions which were attended by about a fifth of the student population*"). Engagement levels with office hours were mixed: some reported higher engagement levels than usual ("*Honours students seemed to demand more of my time when communication was online (Skype/Zoom)*") while others reported consistently low engagement with only the most engaged attending ("*My most keen students (4 out of a class of 160) came to my office hour each week*").

3.4.4. Video Conferencing Software

Video-conferencing software, such as Zoom, Teams, or Skype, was mentioned in 18.9% of comments, with respondents observing that, in group situations, some "*(s)tudents mainly communicated using chat, rather than speaking*." In fact, several respondents stated that they "*felt like more students interacted during the online teaching*," and theorised that this may be due to the fact that "*the message board is more anonymous than a real life lecture*."

Some respondents set up a discussion forum for their students to use, both for direct support from the lecturer or for peer support, with 10.5% of comments referencing this. However, in general, these do not seem to have been a success in terms of engaging with students ("*The forums I set up were not favoured by the students*").

4. Discussion

4.1. Student Difficulties

We aimed to address three research questions in this paper. The first of these concerned the particular difficulties students encountered of which their lecturers were aware. Our findings echoed those of the numerous other studies mentioned previously in relation to challenges for students finding fast, reliable broadband. Two-thirds of lecturers in our survey stated they were made aware of difficulties like this. Over two-fifths of respondents knew of hardware difficulties their students were having, while a third reported software difficulties. These three figures are higher, in general, than those from other studies which sought to address this question. However the other studies mentioned were conducted

with students as opposed to academic staff. Optional online student surveys are less likely to be completed by students who have poor access to broadband or a laptop, whereas they are more likely to report these difficulties to their lecturers in order to explain absences or request help. Indeed, two survey respondents felt that some such difficulties had been exaggerated to them by their students, although many other respondents voiced concern that they had many students who were disengaged but had not identified as having difficulties. The extent to which students might have over- or under- exaggerated their difficulties is a factor that can neither be controlled nor measured, but should be borne in mind as a possibility when considering the responses.

In terms of personal difficulties, lecturers raised childcare issues as being one challenge for their students to overcome. Without access to the details of the students involved, we cannot accurately judge whether this reflects the broader trend observed by [28,29] that female students would have been disproportionately affected by this issue. However, lack of childcare while attempting to engage in online study is likely to greatly impact a student's ability to meaningfully engage with their degree programme, and lead to poorer outcomes for them than a student without these challenges. This is an area for further research, and given the global nature of our survey, we suggest that this could have been an issue for many student parents.

There are echoes of Soria and Horgos' work [10] in our findings, with lecturers highlighting students struggling to study while confined to homeless accommodation or having no space of their own to work in. Respondents also mentioned those who had to work more than usual, in frontline jobs such as supermarkets, or at home on a farm. Indeed, these and many of the technology-related difficulties cited earlier (e.g., inability to access hardware or trouble obtaining a reliable internet connection) are more likely to impact those of low socio-economic backgrounds, who do not have the means to purchase new equipment or pay for stronger broadband. The data we obtained suggested that links between social class and difficulties experienced by students did not relate solely to any one country or region, suggesting that this was indeed a challenge facing many students from lower socio-economic backgrounds worldwide.

A number of respondents highlighted their concerns around mental health issues arising for students at this time, which reflects the findings of [26]. In our survey, in addition to comments that specifically dealt with students with diagnosed mental health issues, many respondents commented on the raised stress levels they observed among their students. They attributed this to illness, lack of routine, and students generally not being fully equipped to learn online. Again, our findings did not link only to respondents based in one particular country, suggesting that this may have been quite a universal experience of students during this time.

In relation to those with specific learning difficulties or disabilities, less than 15% of respondents were aware of particular difficulties encountered by such students during this time. This relatively low number possibly suggests that lecturers were not fully aware of the difficulties experienced by these students during emergency remote teaching. The issues raised by our respondents related mostly to a lack of functionality within the equipment to address the specific mathematical needs of their students, and less to a lack of technological equipment. This most likely reflects the different needs of students with accessibility barriers when studying mathematics compared to other disciplines, and highlights an important difference when considering the challenges of teaching mathematics online in an accessible manner.

4.2. Student Attendance

Our second research question dealt with the issue of attendance levels at online teaching sessions. Overall, attendance was deemed to be lower online than in-person, with a mere 11.3% of respondents reporting higher attendance levels online. However, the comments revealed similar disparities to those noted in the literature, whereby experiences varied in different settings. Some respondents observed that students were more engaged

than usual, while others had the opposite experience, stating that even attendance at compulsory classes was less than it should be. In addition, one lecturer raised the issue of the adverse impact of the necessary assessment changes on attendance, where students stopped attending when it was no longer necessary.

4.3. Engagement with Students

Our final research question queried the level of engagement lecturers had with their students during this period. In this study, "student engagement" refers to the level of communication and interaction between students and their lecturers. Our results are somewhat reflected in the work of [4,23], which was mentioned earlier. In our significantly larger sample, a similar four-fifths of respondents stated that they had regular engagement with their students, with scheduled, optional, weekly sessions being the most common form. Many of the other studies mentioned previously [18,20,21] dealt solely with student attendance, or considered the level of interaction during teaching sessions, but our findings provide evidence that many lecturers were, in fact, offering engagement opportunities beyond their regular teaching sessions, albeit with mixed levels of success. Many noted the difficulty of quantifying that student interaction, observing how there may have been only a small number of students making use of particular engagement opportunities, but those who were doing so were clearly benefitting from them.

4.4. Overall Theme

One overarching theme that emerged across responses to all our questions was that of many lecturers going above and beyond for their students during this time. For example, one respondent, while detailing how some of their students struggled with poor Wi-Fi, stated that they went into their office to print notes for their students. Other respondents detailed acquiring laptops for students who did not have any; spending additional time on pastoral care with students; compressing video files or separately emailing links to recorded Zoom files to students who were struggling to access them due to poor broadband; making themselves available for video conferencing outside of regular working hours for students who had work commitments; or answering emails within a very short time frame. The lack of regular, in-person interaction with their students was something with which lecturers also struggled, and the desire for a return to in-person teaching was strong in many responses.

4.5. Limitations

We acknowledge that there were some limitations to the study. Firstly, the survey was available only in English and exclusively online. As such, there is no way of knowing how representative the sample is of mathematics lecturers in higher education overall. Secondly, the vast majority of respondents were based in Europe, and their experience might not replicate that of respondents from other continents. Thirdly, there is the potential of bias within the responses provided by the lecturers. In addition, there was a larger than typical representation of females in our sample, possibly due to the fact that the survey was emailed to a mailing list for female mathematicians. This may have impacted the data attained, as female academics have been reported to have been disproportionately affected by the pandemic in terms of productivity and output [36,37], with the result that they may be more in tune with the impact of the pandemic on students. Finally, we are aware that not all students contacted their lecturers during the initial months of the pandemic, and neither their voices nor their challenges are represented here. Of those that did contact their lecturers, there is the possibility of over- or under-exaggeration of difficulties and challenges faced, and this is acknowledged as a limitation of the study.

5. Conclusions

This paper contributes a unique perspective on the mathematics student experience during the initial university closures, giving an international perspective from 256 lecturers

based in 29 countries. This study makes explicit both the personal and academic challenges that students face when attempting to learn mathematics online. It is a unique perspective on an unprecedented situation that has not been explored until now. It provides key insights for practitioners on the student perspective that should considered for future online or blended learning. Many of our findings have provided more solid confirmation of those from smaller, more regional studies, while others, such as the situation for students with learning difficulties or disabilities, or the challenges of students without access to childcare, appear to be unreported as of yet, either in relation to mathematics for the former, or at this scale for the latter.

One major outcome of this research is the exposure it gives to the fact that education in a remote capacity can be a very unlevel playing field for students. Further research into the multifaceted circumstances and challenges faced by students in a remote learning environment are warranted. How can we cater for all students simultaneously, so that those with inadequate Wi-Fi and/or hardware/software, or difficult personal circumstances, will not be unfairly penalized? What provisions can be made for students with disabilities during remote learning? What training can be provided to lecturers in this situation to ensure they can maximise their students' learning? A follow-up survey was issued a year after our initial one in order to ascertain how lecturers and students experienced online teaching and learning in mathematics, as both groups grew more used to the technology and new style of communicating mathematics. The findings of this new survey will be published in due course, and will provide further insight into remote teaching and learning of mathematics.

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Appendix A. Survey Questionnaire

The 'Student Experience' section of the survey

Q1. Did any of your students let you know that they had difficulty accessing material due to issues with:

	Yes	No
Broadband/Wi-Fi		
Hardware (e.g., no laptop)		
Software (e.g., no access code, difficulty downloading)		
Personal Reasons (e.g., caring commitments, illness etc)		

Q2. If yes for any of the above, please comment

Q3. Did any of your students let you know that they had difficulty accessing material due to learning difficulties/disability? (Tick Yes/No)

Q4. If yes, please comment.

Q5. Did students attend online teaching sessions more frequently than regular lectures/tutorials? (Rate: 1 (a lot less frequently)—5 (a lot more frequently)

Q6. Did you have any regular engagement with students at this time? (Tick Yes/No)
Q7. If yes, was any of this engagement:

	Yes	No
Scheduled (e.g., at a particular time of day)		
Unscheduled (e.g., at any time of day)		
Compulsory (e.g., all students had to engage for credit)		
Optional (e.g., students could engage as they wished)		
Daily		
Weekly		

Q8. Please comment on the nature of this engagement.

References

1. Hodges, C.; Moore, S.; Lockee, B.; Trust, T.; Bond, A. The difference between emergency remote teaching and online learning. *Educ. Rev.* **2020**, *27*. Available online: https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning (accessed on 25 October 2022).
2. Engelbrecht, J.; Harding, A. Teaching undergraduate mathematics on the internet. *Educ. Stud. Math.* **2005**, *58*, 253–276. [CrossRef]
3. Ní Fhloinn, E.; Fitzmaurice, O. Challenges and opportunities: Experience of mathematics lecturers engaged in emergency remote teaching during the COVID-19 pandemic. *Mathematics* **2021**, *9*, 2303. [CrossRef]
4. Hyland, D.; O'Shea, A. The student perspective on COVID-19 related closures at Irish universities. *Teach. Math. Appl.* **2021**, *40*, 455–477. [CrossRef]
5. Naidoo, J. Postgraduate mathematics education students' experiences of using digital platforms for learning within the COVID-19 pandemic era. *Pythagoras* **2020**, *41*, 568. [CrossRef]
6. Dodd, R.H.; Dadaczynski, K.; Okan, O.; McCaffery, K.J.; Pickles, K. Psychological wellbeing and academic experience of university students in Australia during COVID-19. *Int. J. Environ. Res. Public Health* **2021**, *18*, 866. [CrossRef]
7. Henaku, E.A. COVID-19 online learning experience of college students: The case of Ghana. *Int. J. Multidiscip. Sci. Adv. Technol.* **2020**, *1*, 54–62.
8. Rahiem, M.D. The emergency remote learning experience of university students in Indonesia amidst the COVID-19 crisis. *Int. J. Learn. Teach. Educ. Res.* **2020**, *19*, 1–26. [CrossRef]
9. Nassr, R.M.; Aborujilah, A.; Aldossary, D.A.; Aldossary, A.A.A. Understanding education difficulty during COVID-19 lockdown: Reports on Malaysian university students' experience. *IEEE Access* **2020**, *8*, 186939–186950. [CrossRef]
10. Soria, K.M.; Horgos, B. *Social Class Differences in Students' Experiences during the COVID-19 Pandemic*; SERU Consortium Reports; Center for Studies in Higher Education, UC Berkeley: Berkeley, CA, USA, 2020.
11. Perkin, G.; Croft, T. The dyslexic student and mathematics in higher education. *Dyslexia* **2007**, *13*, 193–210. [CrossRef]
12. Swanwick, R.; Oddy, A.; Roper, T. Mathematics and deaf children: An exploration of barriers to success. *Deaf. Educ. Int.* **2005**, *7*, 1–21. [CrossRef]
13. Cliffe, E.; Mac an Bhaird, C.; Ní Fhloinn, E.; Trott, C. Mathematics instructors' awareness of accessibility barriers for disabled students. *Teach. Math. Appl. Int. J. IMA* **2020**, *39*, 184–200. [CrossRef]
14. Cooper, M. Making mathematics teaching inclusive-access for disabled students to symbolic languages in electronic media. *MSOR Connect.* **2006**, *6*, 29. [CrossRef]
15. Ahmed, I.; Chao, T. Assistive learning technologies for students with visual impairments: A critical rehumanizing review. *Investig. Math. Learn.* **2018**, *10*, 173–185. [CrossRef]
16. Soria, K.M.; Horgos, B.; Chirikov, I.; Jones-White, D. *The Experiences of Undergraduate Students with Physical, Learning, Neurodevelopmental, and Cognitive Disabilities during the Pandemic*; SERU Consortium Reports; Center for Studies in Higher, UC Berkeley: Berkeley, CA, USA, 2020.
17. Howard, E.; Meehan, M.; Parnell, A. Live lectures or online videos: Students' resource choices in a first-year university mathematics module. *Int. J. Math. Educ. Sci. Technol.* **2018**, *49*, 530–553. [CrossRef]
18. Shenoy, V.; Mahendra, S.; Vijay, N. COVID-19 lockdown technology adaption, teaching, learning, students engagement and faculty experience. *Mukt Shabd J.* **2020**, *9*, 698–702.
19. Gomez, E.; Azadi, J.; Magid, D. Innovation born in isolation: Rapid transformation of an in-person medical student radiology elective to a remote learning experience during the COVID-19 pandemic. *Acad. Radiol.* **2020**, *27*, 1285–1290. [CrossRef]
20. Darici, D.; Reissner, C.; Brockhaus, J.; Missler, M. Implementation of a fully digital histology course in the anatomical teaching curriculum during COVID-19 pandemic. *Ann. Anat. Anat. Anz.* **2021**, *236*, 151718. [CrossRef]
21. Johnson, S.S.; Gaines, M.K.; Van Vleet, M.J.; Jackson, K.M.; Barrett, C.; Camp, D.; Mancia, M.D.L.; Hibbard, L.; Rodriguez, A. Unleashing our chemistry superpowers: Promoting student success and well-being at a black women's college during COVID-19. *J. Chem. Educ.* **2020**, *97*, 3369–3373. [CrossRef]

22. Aguilera-Hermida, P. College students' use and acceptance of emergency online learning due to COVID-19. *Int. J. Educ. Res. Open* **2020**, *1*, 100011. [CrossRef]
23. Radmer, F.; Goodchild, S. Online mathematics teaching and learning during the COVID-19 pandemic: The perspective of lecturers and students. *Nord. J. STEM Educ.* **2021**, 5. [CrossRef]
24. Hodds, M. *A Report into the Changes in Mathematics and Statistics Support Practices Due to COVID-19*; The sigma Network for Excellence in Mathematics and Statistics Support; Loughborough University: Loughborough, UK, 2020.
25. Hussein, E.; Daoud, S.; Alrabaiah, H.; Badawi, R. Exploring undergraduate students' attitudes towards emergency online learning during COVID-19: A case from the UAE. *Child. Youth Serv. Rev.* **2020**, *119*, 105699. [CrossRef]
26. Chirikov, I.; Soria, K.M.; Horgos, B.; Jones-White, D. *Undergraduate and Graduate Students' Mental Health during the COVID-19 Pandemic*; SERU Consortium Reports; Center for Studies in Higher Education, UC Berkeley: Berkeley, CA, USA, 2020.
27. Husky, M.M.; Kovess-Masfety, V.; Swendsen, J.D. Stress and anxiety among university students in France during COVID-19 mandatory confinement. *Compr. Psychiatry* **2020**, *102*, 152191. [CrossRef] [PubMed]
28. Crook, S. Parenting during the COVID-19 pandemic of 2020: Academia, labour and care work. *Women's Hist. Rev.* **2020**, *29*, 1226–1238. [CrossRef]
29. Sevilla, A.; Smith, S. Baby steps: The gender division of childcare during the COVID-19 pandemic. *Oxf. Rev. Econ. Policy* **2020**, *36*, 169–186. [CrossRef]
30. Creswell, J.W. *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*; Pearson: New York, NY, USA, 2004.
31. Ní Fhloinn, E.; Fitzmaurice, O. How and why? Technology used by university mathematics lecturers for emergency remote teaching during the COVID-19 pandemic. *Teach. Math. Appl.* **2021**, *40*, 392–416. [CrossRef]
32. Thomas, D.R. A general inductive approach for analyzing qualitative evaluation data. *Am. J. Eval.* **2006**, *27*, 237–246. [CrossRef]
33. Thomas, D.R. *A General Inductive Approach for Qualitative Data Analysis*; School of Population Health, University of Auckland: Auckland, New Zealand, 2003.
34. Vaismoradi, M.; Snelgrove, S. Theme in qualitative content analysis and thematic analysis. *Forum Qual. Soz. (FQS)* **2019**, *20*, 23. [CrossRef]
35. O'Connor, C.; Joffe, H. Intercoder reliability in qualitative research: Debates and practical guidelines. *Int. J. Qual. Methods* **2020**, *19*, 1609406919899220. [CrossRef]
36. Deryugina, T.; Shurchkov, O.; Stearns, J. COVID-19 disruptions disproportionately affect female academics. *AEA Pap. Proc.* **2021**, *111*, 164–168. [CrossRef]
37. Andersen, J.P.; Nielsen, M.W.; Simone, N.L.; Lewiss, R.E.; Jagsi, R. COVID-19 medical papers have fewer women first authors than expected. *eLife* **2020**, *9*, e58807. [CrossRef]