MatRIC Survey of online mathematics teaching and learning spring semester 2020

A Preliminary Report Farzad Radmehr and Simon Goodchild

Introduction

The global spread of the novel coronavirus, Covid-19, reached Norway at the end of February 2020. The first cases in Norway were detected on February 26; these were among people returning from business or holiday visits to Italy or Austria. As soon as the beginning of the second week in March 2020, it had become clear that the virus was spreading rapidly within the Norwegian population. On Thursday, March 12, the Norwegian Government took action and locked down the community restricting all non-essential activity with immediate effect. Universities were closed; lecturers and students were required to move to online teaching and learning from the following Monday, March 16.

Some mathematics lecturers in Norway had been experimenting with digital tools for teaching and learning mathematics for some time before the lockdown. The digital tools included video-recorded lectures or short expositions of mathematics, podcasts, streamed lectures, dynamic digital simulations and illustrations of mathematical representations, functions and models, digital assessment applications, and social media. However, for many, the requirement to suddenly move to online teaching was an unwelcome shock for which they were not well prepared.

MatRIC, Centre for Research, Innovation and Coordination of Mathematics Teaching is a Norwegian Centre for Excellence in Education. MatRIC aims to support all higher education mathematics lecturers and students in Norway by facilitating the exchange of ideas for good practices in all areas of mathematics teaching and learning. MatRIC was challenged to conduct a national survey of online mathematics teaching and learning in Norwegian higher education institutions (HEIs) to explore lecturers' and students' experiences and enable the sharing of solutions to the challenges encountered. This report is a preliminary presentation of findings from the survey. The instrument was prepared over the period April 24 – June 06, and the survey conducted amongst Norwegian higher education mathematics lecturers at the close of the spring semester 2020 (June 06 – July 04).

1

Summary

The small number of responses by both lecturers and students to the survey prevent any claims that the findings are representative. However, the experience and gender profiles of informants and their places of employment provide grounds to believe that a broad range of experiences is exposed by the survey.

Any shock resulting from the sudden imposition of teaching and learning online was probably more widespread among lecturers than students. Before the lockdown and online teaching began students' attendance at lectures and seminar-type activity was not high. It seems likely that many students were already familiar with remote learning using streamed lectures, etc. Further, a higher proportion of students responded positively to questions about the use of online teaching/learning materials.

After the lockdown few lecturers followed exactly the regular schedule set beforehand. Lecturers recorded their lectures, either as complete sessions or as a set of mini-lectures. Zoom was the main application for video meetings. It appears that a wide range and variety of digital applications and online resources are available, either freeware or commercial licence. The challenge is how one can be well-informed about the possibilities available. (Section 3 below, page 8, offers some ideas that emerged from the survey).

Live interaction between lecturers and students clearly suffered during the lockdown. Lecturers took a number of steps to ensure lines of communication remained open, primarily through learning management software (e.g. Canvas and Blackboard), and Zoom. Students want communication that is: live, anonymous, timely, functional and announced in advance. Simple actions by the lecturer to open channels of communication can be very effective.

The lack of being physically present at the university and missing social contact were high among the negative consequences experienced by students. Also, the requirement that students take more responsibility for their work was keenly felt by many.

Around 40% of students experienced a degree of anxiety through the lockdown period to the extent that they believe their learning was negatively affected.

Lecturers who are sensitive to the impact on students learning and emotional welfare, and who are aware of how the impact can be reduced, can make a positive difference.

2

Methodology

We wanted to create a survey instrument that was manageable for respondents and relatively easy to analyse; thus, we wanted to make extensive use of closed questions with multiple-choice answers. The creation of an instrument to explore experiences of a novel phenomenon such as the sudden and unexpected imposition of online teaching that occurred due to the Covid-19 crisis is particularly challenging. The danger is that the instrument reflects the restricted experiences of the researchers and does not explore sufficiently all the experiences of those who made the transition to online teaching and learning. We developed the instrument through several stages.

To meet the challenge, we first interviewed a sample of 10 mathematics teachers of varying lengths of teaching experience in higher education and six students. We structured the interviews around several open questions that provided the respondents with the opportunity to describe their experiences. These questions emerged out of several discussions between the researchers. The questions were distributed to respondents in advance so they would have the opportunity to reflect on their experiences and consider how they would respond. Interviews were conducted online (using Zoom) and recorded. One researcher conducted the interview, a second listened in and made notes, only at the end of the interview did the second researcher enter the conversation and explored in greater depth some of the issues that had arisen.

We based the next stage of developing the instrument on our analysis of responses from the interviews. In retrospect, we could have anticipated many of the issues that arose from the interviews. These include the absence of physical presence, of being able to share in the written production of mathematics test, and students' lack of anonymity when engaging through social media or learning management systems were frequent observations. We were perhaps most struck by the affective/emotional impact on students who suffered from loss of social interaction, the breakdown of the separation of home and university working spaces, lack of structure and daily routine, and anxiety. We built these issues into the survey instrument.

The first draft of the instrument was produced in English and sent to several international experts in higher education mathematics teaching, learning support and university mathematics education research. Their reflections led us to make mainly structural modifications to the instrument rather than changes in the content or intent of items in the instrument. A second draft was produced in English and translated into Norwegian. An experienced mathematics lecturer checked the Norwegian translation. Following minor modifications to language, we distributed the instrument (Norwegian and English versions) using an online survey tool (SurveyXact) to mathematics teachers in Norwegian higher education institutions through the MatRIC Contact Group.

The stages of instrument preparation, distribution data collection and analysis were approved in advance by the Norwegian data protection agency (NSD). NSD considers both the General Data Protection Regulations (GDPR) and ethical issues arising from the collection of personal data.

Given the careful process followed for the construction of the instrument, we claim that the responses to the instrument are more significant than would be the case if the instrument were based only on the researchers' thought experiment.

Report from the preliminary analysis of responses

1. Background information about the participants

MatRIC distributed the survey during June 2020. A link to the online survey instrument was sent to members of the MatRIC Contact Group with the request that it be distributed to colleagues and students at their institution who had experienced online mathematics teaching during the lockdown. One hundred and twenty-seven students and eighteen lecturers completed the survey. The students were from four Norwegian universities; however, the majority (90%) participated from one university. This is a disappointing response from students. If we add the students interviewed earlier regarding online teaching and learning of mathematics in the lockdown period, there are representatives from five universities altogether. This is insufficient to make any claims about representativeness, but it may be sufficient to validate some of the key responses from the lecturers.

Regarding the lecturer sample group, seven universities are represented in the responses to the online survey; there were additional institutions represented in the interviews. In total, ten institutions are represented, including Norway's major universities. As with the students, there were relatively few lecturers who completed the survey. In total, 18 individual respondents plus up to ten additional respondents from the interviews (assuming the interviewees did not also complete the survey), it is not likely to be genuinely representative of the Norwegian HEI mathematics lecturing community. However, the fact that the largest institutions are represented will enable insight into institutional characteristics, and the respondents will give a sense of variations within and across institutions.

The lecturers had a wide range of experiences of teaching mathematics in higher education as a lecturer/associate professor/professor from a minimum of 3 to a maximum of 39 years. The mean of their teaching experience was 14.07 years, with a standard deviation of 11.28. For subsequent analysis¹, The lecturers have been organised into one of three broad categories of experience, as shown in Table 1.

The	distribution	of the	lecturers in	the	categories	
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Study year	Frequency	Percent
Low (3-5)	4	22.2
Medium (8-12)	7	38.9
High (20-39)	4	22.2
Missing information	3	16.7

¹ These analyses will be reported in the final report.

Regarding the student sample group (Table 2), the majority (90%) were first and second-year students. However, there are probably sufficient representatives of students in their first and later years to be able to see whether the students who had longer to adjust to higher education found it easier to readjust to the lockdown².

Table 2

Students' study year

Study year	Frequency	Percent
First-year	86	67.7
Second-year	28	22.0
Third-year	8	6.3
Fourth-year or higher	5	3.9

The gender distribution of the participants is provided in Table 3, indicating a good gender balance for the student sample group. The lack of gender balance in the lecturer respondents is not surprising as it is probably a reflection of the gender balance of the mathematics teaching force in higher education.

Table 3

The gender distribution of the participants

	Ma	ale	Fer	nale	Missing information				
	N	%	Ν	%	Ν	%			
Students	59	46.5	57	44.9	11	8.7			
Lecturers	15	83.3	2	11.1	1	5.6			

The majority of lecturers and students were involved in the teaching/learning of one or two mathematical courses during the period of lockdown, as indicated in Table 4.

Table 4

Experience of online teaching/learning during the period of lockdown

	One mat	hematics	Two ma	thematics	Three or more				
	cou	irse	СС	ourse	mathematics courses				
_	Ν	%	Ν	%	Ν	%			
Students	90	70.9	31	24.4	6	4.7			
Lecturers	11	61.1	6	33.3	1	5.6			

² This analysis will be reported in the final report.

2. Teaching and learning practices before the lockdown. A sketch of the background of the sudden emergency imposition of online teaching.

Lecturers were asked to indicate student attendance in lectures and seminars/problem classes before the lockdown started. The responses reveal that attendance at classes, either lectures or seminar-type group activity was not high. One implication from this is that many students were probably familiar with routines for learning independently, - online, using streamed lectures or other approaches.

Lecturers and students were asked about their experience of online teaching/learning before the lockdown. The responses (Table 5) show that it seems students had more experience of engaging with online education than the lecturers as 71.2% students chose the first three items, whereas this percentage was only 38.9% for lecturers.

Table 5

	The experience of students and rectarers regarding online education before the lockdown													
Iter	ns	Stuc	dents	Lecturers										
_		Ν	%	Ν	%									
1.	Extensive, very experienced.	7	5.5	0	0									
2.	Good, familiar with most programs/Apps and used some of them.	35	27.6	3	16.7									
3.	Moderate, familiar with some programs/Apps but little experience of use.	49	38.6	4	22.2									
4.	Poor, little familiarity, limited use.	30	23.6	8	44.4									
5.	Non existent.	6	4.7	3	16.7									
	Fisher's Exact Test		0.07	2										

The experience of students and lecturers regarding online education before the lockdown

In this report, we used Fisher's exact test to examine the association between the responses of students and lecturers to the items of the questionnaire. We will also use this test in the final report to examine the association between the response of female and male students, the association between the responses of students within different study year, and the association between the responses of lecturers with different years of experience of teaching mathematics. The findings indicate that there was a significant difference (P=0.072³) between the experience of students and lecturers regarding online education before the lockdown.

One needs to be very careful about drawing direct comparisons between lecturers and students. It appears in the responses to the questionnaire, a much higher proportion of students had some prior experience of using online learning resources than the proportion of lecturers that had prior of using

³ In this report, because of the small sample size, we considered p-value of less or equal 0.1 as significant

online or digital resources in their teaching. This could impact on later responses to questions because the cohort of students responding had greater familiarity with online teaching/learning than the lecturers.

3. Online teaching

Whereas lecturers had a wide choice about how they would respond, to the lockdown, students' choices were restricted by the choices made by their lecturer. Note that nearly 50% of lecturers did not follow the scheduled plan with "live" streamed lectures, a close examination of the responses reveals that most of these made use of recorded lectures or mini-lectures that were prepared specially for the lockdown period. A close examination of student responses reveals that high proportion of them (67%) made use of (for at least 70% of the time) recorded lecturers or mini-lectures, either prepared specially for the lockdown or from previous years.

Lecturers and students were asked about their experience of using several online teaching/learning applications (Table 6). It seems that many students and lecturers used Zoom as a tool for online education. The usage percentages of these two groups were relatively close, and their perceived experiences were somewhat similar. In addition, it seems Facebook and YouTube have been used by students much more than the lecturers. If a group of students use YouTube as a learning resource, they might benefit from some channel suggestions from the lecturers who know the materials are sound and useful for students.

Lecturers and students were asked further in an open response question to indicate whether they used any other online tools than those named in the closed questions.

From the open response questions:

Lecturers (Experience of digital tools during the lockdown)

- The introduction of "Padlet" as an alternative to "Piazza" needs to be noted. NTNU has a licence for "Padlet", but it is possible to download a free version at padlet.com.
- There are some solutions to sharing writing space and handwritten text such as Microsoft
 Whiteboard (free and works on iOS), and awwapp which is not free (US\$9,00 per month),
 probably need a Surface or similar computer, and it is not available through Apple's Appstore.
- Some lecturers are using production equipment to mix video sources. It is not clear how this compares in detail with Kaltura, for example.

Table 6

Students and lecturers perceived experiences of different online teaching/learning applications

Items	Category	Ver	y poor	Р	oor		ОК	G	Good		y good	Not (kn us	owingly) sed	Fisher's Exact Test
		Ν	%	Ν	%	Ν	%	Ν	%	Ν	%	Ν	%	
1. Zoom	Students	5	3.9	8	6.3	21	16.5	36	28.3	18	14.2	39	30.7	.801
	Lecturers			1	5.6	1	5.6	6	33.3	4	22.2	6	33.3	
2 Adoba Connact	Students	3	2.4	2	1.6	4	3.1	3	2.4	1	.8	114	89.8	.161
2. Adobe connect	Lecturers	1	5.6	1	5.6			2	11.1			14	77.8	
3. Blackboard	Students	1	.8	3	2.4	4	3.1	2	1.6	1	.8	116	91.3	.399
	Lecturers			1	5.6	1	5.6	1	5.6			15	83.3	
4. Teams	Students	3	2.4	2	1.6	8	6.3	14	11	9	7.1	91	71.7	.303
	Lecturers	1	5.6			3	16.7			1	5.6	13	72.2	
E Skype/Skype for husiness	Students	1	.8	5	3.9	10	7.9	9	7.1	4	3.1	98	77.2	.183
5. Skype/skype for busiliess	Lecturers	2	11.1			2	11.1	1	5.6			13	72.2	
6 Diazza	Students	4	3.1	1	.8	3	2.4	2	1.6			117	92.1	.233
0. Plazza	Lecturers							1	5.6	1	5.6	16	88.9	
7 Facebook	Students	5	3.9	4	3.1	17	13.4	18	14.2	10	7.9	73	57.5	.051
7. Facebook	Lecturers											18	100	
8 VouTubo Vimoo /Kaltura	Students	1	.8	4	3.1	25	19.7	24	18.9	25	19.7	48	37.8	.005
8. Yourube/ villeo/ kaltura	Lecturers							3	16.7			15	83.3	
9. Computer Aided Assessment	Students			2	1.6	7	5.5	7	5.5	4	3.1	107	84.3	.927
tool such as STACK, Numbas,	Lecturers					1	5.6					17	94.4	
MapleTA, MyMathLab, SOWISO,														
etc.														
10. Audience Response	Students	1	.8	1	.8	11	8.7	7	5.5	5	3.9	102	80.3	.652
Software (Such as Kahoot, Socrative)	Lecturers					3	16.7					15	83.3	

Students (Use of online learning resources)

- Students appear to have found several different solutions to support their group work (Discord, miro). Also, online places to solve mathematical tasks. Some resources mentioned by students that do not appear in Table 6 were:
- YouTube channels: BlackpenRedpen; Michel Van Biezen; Khan Academy; 3Blue1Brown;
- <u>https://udl.no/</u>; (YouTube videos)
- o Wikipedia
- o Pearson.no
- <u>https://miro.com/</u> The online collaborative whiteboard platform to bring teams together, anytime, anywhere.
- o Online calculator with solution suggestions
- o SimReal
- o http://www.ilectureonline.com/

It seems that recorded lectures can work well, lecturers need to attend to the quality of presentation and explanation, length of the video, and quality of equipment. However, the recorded lecture does not allow the student to interrupt and ask questions.

Canvas, and the resources and functionality has received a lot of positive responses. The students appear to have found several online solutions and smartphone Apps to support them in their working and learning.

Whether prompted by the lockdown, or for other reasons, there are many digital "solutions" to meet the challenges of teaching and learning mathematics online. It appears that students may be better aware of the applications available than teachers. It could be a valuable exercise to establish a form of "information exchange" in which challenges and solutions are shared. This is something that MatRIC might try to set up and coordinate, but it will only be effective as it used by the mathematics teaching and learning community. This is something we could set up on the MatRIC server.

4. Communication between the lecturer and individual students

Lecturers and students were asked to indicate which of the following applications (see Table 7) were used for students **to make contact and ask questions** – and get answers either from the lecturer or student learning assistant(s). Fisher's exact test revealed that there was a significant difference between student and lecturer experience of using Zoom for making contact and ask questions. In detail, 42% of students perceived their experience of using Zoom as a tool for making contact and ask questions good and very good, whereas this percentage was only 22.2% for lecturers.

The descriptive statistics shared in Table 7 show that Zoom, Canvas, and e-mails were the main tools for making contact and asking questions. 59.7% of students rated their experiences of using Canvas *good* or *very good*, whereas these two options (i.e., good and very good) were chosen by 46% of students for e-mail and by 42% of students for Zoom.

Table 7

Students and lecturers perceived experiences of the effectiveness of different online applications for making contact and ask questions

Ite	ms	Category	V	ery	Р	oor	(ЭК	G	ood	V	ery		Not	Fisher's
			р	oor							g	bod	(kno	wingly)	Exact
													ι	ised	Test
			Ν	%	Ν	%	Ν	%	Ν	%	Ν	%	Ν	%	
1.	Zoom	Students	1	.8	4	3.2	20	16.1	26	21	26	21	47	37.9	.006
		Lecturers	1	5.6	4	22.2	3	16.7			4	22.2	6	33.3	
2.	Teams	Students	1	.8	2	1.6	6	4.8	4	3.2	8	6.5	103	83.1	.128
		Lecturers	1	5.6			3	16.7	1	5.6			13	72.2	
3.	Skype/skype	Students			3	2.4	5	4	6	4.8	7	5.6	103	83.1	.082
	for business	Lecturers	1	5.6	1	5.6	2	11.1	1	5.6			13	72.2	
4.	Adobe	Students	1	.8	2	1.6	3	2.4	3	2.4			115	92.7	.205
	connect	Lecturers			1	5.6	2	11.1					15	83.3	
5.	Piazza	Students	1	.8	3	2.4	2	1.6	1	.8			117	94.4	.159
		Lecturers							1	5.6	1	5.6	16	88.9	
6.	Canvas	Students	3	2.4	13	10.5	19	15.3	42	33.9	32	25.8	15	12.1	.273
		Lecturers			1	5.6	2	11.1	7	38.9	2	11.1	6	33.3	
7.	Blackboard	Students			3	2.4	2	1.6	2	1.6			117	94.4	.191
		Lecturers							2	11.1			16	88.9	
8.	Facebook	Students	1	.8	5	4	14	11.3	9	7.3	11	8.9	84	67.7	.376
		Lecturers							1	5.6			17	94.4	
9.	E-mail	Students	1	.8	6	4.8	29	23.4	33	26.6	24	19.4	31	25	.550
		Lecturers					4	22.2	6	33.3	6	33.3	2	11.1	
10	Telephone	Students	1	.8	2	1.6	11	8.9	8	6.5	4	3.2	98	79	.195
		Lecturers			1	5.6	3	16.7	1	5.6	2	11.1	11	61.1	
11	WhatsApp	Students			3	2.4	3	2.4	2	1.6			116	93.5	1
		Lecturers											18	100	
12	Facetime	Students	1	.8	4	3.2	1	.8	2	1.6			116	93.5	1
		Lecturers											18	100	

As above, lecturers and students had the opportunity to respond to an open question about how contact between lecturers and students was made.

Lecturers

• (*Making contact students to lecturers*). The issue of anonymity is raised. We have been informed that it is possible in "Piazza" for students to remain anonymous; we do not know if this is

possible in Padlet. We do know from the interviews that anonymity is an issue for the students. The lecturer that has used Padlet appears satisfied with their experience.

- (*Making contact lecturers to students*). Some of the calls/contacts with students were made for administrative or operational reasons, to inform of a change in schedule or about assessment requirements. However, many appear to be made out of a concern to support students:
 - 1. To follow up missing assignments;
 - 2. To ensure a "silent" or "invisible" group was working OK;
 - 3. To make it easier for students to make contact; and
 - 4. To follow up after receiving information about students from another source.

Students

- Students want the interaction:
 - 1. Live to discuss and get immediate feedback
 - 2. Anonymous to be protected from wide scrutiny by their peers
 - 3. Timely available when wanted
 - 4. Functional to work as expected
 - 5. Announced clear communicated when live online help is available
- It seems that reasonably simple actions by the lecturer, to open channels for making contact, can support the students in finding help when wanted.

Additional support for students

Students were asked to indicate if any additional support offered by their institution, faculty, department or unit that has helped them through this period of lockdown (e.g. drop-in mathematics support, additional equipment, etc.). The responses showed that ten students (8%) received such support. Analysing the open-ended question followed this question showed the nature of support students received:

- Online drop-in support received most mentions (also noted, missed physical/visible contact with support tutor and other students);
- Availability of student learning assistants; and
- Online, digital help, such as WolframAlpha.

5. Challenges of learning and teaching mathematics online Challenges students experienced during the lockdown period of online teaching (anticipated and actual)

There was a significant difference between student and lecturer responses to the twelve items that explored the challenges students experienced during the lockdown period of online teaching. We report these items and responses in detail in Table 8. One of the reasons for these differences might be the slightly different way in which items were formulated.

The descriptive statistics shared in Table 8 show some notable challenges students experienced during the lockdown period of online teaching, including 57.7% of students *moderately* or *very much* missed the availability or physical presence of the lecturer or student learning assistants to ask questions; 54.5% of students *moderately* or *very much* experienced social isolation and missing friends and colleagues to work with; 54.4% of students *moderately* or *very much* experienced missing the live presentation of mathematics by a physically present lecturer; 43.9% of students experienced *moderately* or *very much* lack of motivation or confidence to come online to ask questions and get help; 43.1% of students *moderately* or *very much* experienced that they need to take more responsibility for their own learning; 39.8% of students *moderately* or *very much* experienced that they need to take it was difficult to complete assignments, especially assignments based on group activity; 35.8% of students *moderately* or *very much* experienced when the lockdown was suddenly imposed and finding it difficult to adapt to the new teaching/learning routine; and 35% of students *moderately* or *very much* experienced increased anxiety because there were no other students to help pace the progress through the mathematics or to measure progress against.

Table 8 also shows how much lecturers were aware of these challenges and how much actions they have taken to addresses these challenges. For instance, for the first item, only 11.2 % of lecturers considered this challenge deeply and took moderate action.

Additionally, the wellbeing of students should be considered more by the universities and lecturers (see results of Table 9). Regardless of the significant difference found between the responses of students and lecturers, the descriptive statistics shared in Table 9 show that universities and lecturers need to be mindful of the wellbeing of their students and how that impacts their learning. Almost 20% to 42% of students responded that these items affected their learning *some* or *very much*.

Table 8

Challenges students experienced during the lockdown period of online teaching

Student choices		Did not experienced at all Did not consider this as important or relevant.		I experienced some challenge but I took effective action and did not suffer Considered and felt it was students' responsibility to take action.		l experienced some challenge and took some action to get help, but the challenge remained. Considered and took some action.		Experienced this moderately Considered deeply and took moderate action.		rienced much	Not applicable		Fisher's Exact Test
										Considered deeply and took strong action.		Not licable	
	Ν	%	Ν	%	Ν	%	Ν	%	Ν	%	Ν	%	
 S. Social isolation and missing friends and colleagues to work with. L. Students would suffer social isolation and miss friends and colleagues to work with 	12 1	9.8 5.6	28 6	22.8 33.3	14 6	11.4 33.3	32 2	26 11.1	35	28.5	2 3	1.6 16.7	Less than 0.001
S. Missing the routine and structure of coming to university and following the daily schedule. L. Students would miss the routine and structure of	14	11.4	20 6	16.3 33.3	9 4	7.3 22.2	23 2	18.7 11.1	55 2	44.7 11.1	2 4	1.6 22.2	Less than 0.001
coming to university and following the daily schedule.													
S. Missing the availability or physical presence of the lecturer or student learning assistants to ask questions.	19	15.4	22	17.9	10	8.1	32	26	39	31.7	1	.8	Less than 0.001
L. Students would miss the availability or physical presence of the lecturer or student learning assistants to ask questions.			1	5.6	11	61.1	2	11.1	1	5.6	3	16.7	
S. Missing the live presentation of mathematics by a physically present lecturer.	17	13.8	26	21.2	8	6.5	23	18.7	44	35.8	5	4.1	Less than
L. Students would miss the live presentation of mathematics by a physically present lecturer.	2	11.1			7	38.9	3	16.7	2	11.1	4	22.2	0.001
S. Too many distractions at home (by other people, pets, entertainment, etc.).	19	15.4	28	22.8	19	15.4	25	20.3	28	22.8	4	3.3	0.001
L. Students would be distracted at home (by other people, pets, entertainment, etc.).	1	5.6	10	55.6	3	16.7	1	5.6			3	16.7	

Student choices		d not rienced t all ot	l expe some c but I too action a su Consid	l experienced some challenge out I took effective action and did not <u>suffer</u> Considered and		l experienced some challenge and took some action to get help, but the challenge remained. Considered and		Experienced this moderately Considered		ienced much idered	۲ app	Not licable Not	Fisher's Exact Test
		consider this as important or relevant.		felt it was students' responsibility to take action		took some action.		oly and noderate tion.	deeply and took strong action.		applicable		
	N	%	N	%	Ν	%	N	%	Ν	%	Ν	%	
S. Increased anxiety because there were no other students to help pace the progress through the mathematics or to measure progress against.	39	31.7	20	16.3	15	12.2	27	22	16	13	6	4.9	0.006
L. Students would experience increased anxiety because they have no other students to help them pace themselves or measure their own progress against.	3	16.7	6	33.3	4	22.2	1	5.6			4	22.2	
S. Lacking necessary or adequate resources (broadband, computer, writing tablet, etc.).	91	71.4	14	11.4	6	4.9	5	4.1	3	2.4	4	3.3	Less than
L. Students would not possess necessary or adequate resources (broadband, computer, writing tablet, etc.).	5	27.8	6	33.3	2	11.1					5	27.8	0.001
S. Discomfort with the loss of anonymity or privacy in using social media chat forums for sharing mathematical difficulties.	73	59.3	11	8.9	3	2.4	11	8.9	10	8.1	15	12.2	0.002
L. Students would be uncomfortable with the loss of anonymity or privacy in using social media chat forums for sharing their mathematical difficulties.	4	22.2	4	22.2	4	22.2	2	11.1	1	5.6	3	16.7	
S. Lacking motivation or confidence to come online to ask questions and get help.	29	23.6	25	20.3	11	8.9	34	27.6	20	16.3	4	3.3	Less than
L. Students would lack motivation or confidence to come online to ask questions and get help.	2	11.1	4	22.2	8	44.4	1	5.6			3	16.7	0.001
S. Difficult to complete assignments, especially assignments based on group activity.	22	17.9	23	18.7	12	9.8	31	25.2	18	14.6	17	13.8	0.05
L. Students would experience difficulty in completing assignments, especially assignments based on group activity.	2	11.1	4	22.2	5	27.8	2	11.1			5	27.8	

Student choices		d not rienced t all	not I experienced enced some challenge all but I took effective action and did not suffer			nced some e and took tion to get but the e remained.	Expe this m	rienced oderately	Exper very	rienced much	Not applicable		Fisher's Exact
Lecturer choices	Did not consider this as important or relevant.		Considered and felt it was students' responsibility to take action.		Considered and took some action.		Considered deeply and took moderate action.		Considered deeply and took strong action.		Not applicable		Test
	N	%	Ν	%	Ν	%	Ν	%	Ν	%	Ν	%	
S. The requirement to take more responsibility for my own learning.	30	24.4	28	22.8	13	10.6	29	23.6	20	16.3	3	2.4	Less than
L. Students would need to take more responsibility for their own learning.			4	22.2	11	61.1					3	16.7	0.001
S. The shock experienced when the lockdown was suddenly imposed and finding it difficult to adapt to the new teaching/learning routine.	33	26.8	31	25.2	12	9.8	26	21.2	18	14.6	3	2.4	Less than 0.001
L. Students would experience a shock and find it difficult to adapt themselves to the new teaching/learning routine.	2	11.1	2	11.1	8	44.4	1	5.6			5	27.8	

Open responses

Lecturers (Challenges experienced by lecturers).

- The free comments appear to emphasise issues raised in the closed questions. Lecturers appear to miss the feedback possible when students are physically present. Also, acknowledge the problems encountered by students to handwrite and share their mathematics work online.
- (Actions taken to support students). The final comment reveals that it is possible for lecturers to reflect deeply on the importance of live human contact and use the online resources to make this possible.

• The following quotations are reproduced from comments in which there was an opportunity to write free text:

- Først: mine svar må ikke leses som at noen av studentene mine faktisk hadde slike utfordringer, bare at jeg var bekymret for at ulike aspekter ved nettlæring kan være utfordrende for studenter.
- Jeg har flere steder angitt at jeg har vurdert ulike aspekter nøye og satt i gang tiltak, men det er stort sett de samme tiltakene.
- Jeg valgte å sette opp ukentlige nettmøter i Adobe Connect i den vanlige forelesningstiden. Hensikten var å gi studentene en struktur i studieuken, samtidig som de fikk muligheten til å stille spørsmål underveis i forelesningen. Så godt som alle forelesningene hadde noen studentaktiviteter /problemløsningsoppgaver der studentene ble delt inn i mindre grupper og fikk diskutere i et Breakout-room - jeg håper det bidro til å gi dem noe sosial kontakt med andre, samt at det er god læring i å samarbeide/diskutere med andre. Jeg håpet også at dette kunne være en modell for hvordan de kunne jobbe sammen med gruppeoppgaver på egen hånd. Men når det er sagt: gruppeaktivitetene utgjorde nok en for liten del av den samlede forelesningstiden, det vil jeg forbedre til høsten.
- Vi satte opp et ukentlig nettmøte på tidspunktet til seminarundervisningen der var tanken at studentene kunne komme med spørsmål de ville ha svar på.
- I tillegg var det mulig å kontakte meg på epost eller i Canvas, hvis man ikke hadde lyst til å stille spørsmål slik at hele klassen så det/bruke diskusjonsforum.
- The other comments suggest that not all lecturers have engaged in such deep reflection.

Students (Action taken to address the challenge of the situation)

- Four main themes are repeated; there are also some negative comments when the action (one of the four points below) did not work well.
- 1. Group collaboration net-based contact. They are mostly based on groups established before the lockdown.

- 2. Fixed routine mostly determined by students, sometimes around lecturers' structures. Helped to coordinate group collaboration. Setting deadlines and work goals useful.
- 3. Suitable working space quiet, undisturbed, free from distractions.
- 4. Some students found the lockdown a good experience, it aligned with their preferred learning approach, and for some meant less time spent travelling.

(Other challenges?)

The other side of the solutions students found is experienced by those where the same solution misfired or did not exist:

- 1. Difficult with children and other family members.
- 2. Lacking, losing motivation.
- 3. Group or partner collaboration did not function well.
- 4. Difficult to get mathematics help when wanted/needed.
- 5. Inadequate information about the subject, lecturer not well-adjusted to the changed circumstances, competition with other subjects' demands.
- 6. Losing contact with university health support.

Most of the challenges anticipated by the questionnaire were experienced to some extent by a majority of the students. That the questionnaire elicited such high affirmative responses to most questions is not surprising given that the instrument was based upon the responses by interviewees. Of note, however, is that many of the challenges were not anticipated or considered by the lecturers to be part of their responsibility. It is interesting to note that the issues that did elicit positive responses from the lecturers are concerned directly with those elements of practice that they would confront regularly. In other words, it seems that the lecturers did not, did not want to, or were not able to imagine themselves into the experience of individual students and consider what they might do to support the students. This is most likely due to the novelty of the situation, and the fact that lecturers were most likely anxious about their own teaching practice.

If online teaching and learning were to become a significant part of higher mathematics education, it would be necessary to work out responsibilities, structures and strategies to address the challenges students experience.

6. Perceptions of participants on the psychological impact of lockdown

In this section, we explored the psychological impact of lockdown on students and lecturers (Table 9). The participants were asked to indicate how each of the items appeared in Table 9 affected their learning/teaching during the lockdown. The findings indicate two significant differences in the responses of students and lecturers: *Fear for myself and/or my family of being infected by the virus* affected and *uncertainty about the future for myself and/or my family* affected student learning more than lecturer teaching.

Regardless of the significant difference found between the responses of students and lecturers, the descriptive statistics shared in Table 9 show that universities and lecturers need to be mindful of the wellbeing of their students and how that impacts their learning. Almost 20% to 42% of students responded that these items affected their learning *some* or *very much*.

Table 10 shows the perceptions of students and lecturers about the consequences of online teaching in the long term on student learning and outcomes as well as the prospects of the survival of smaller institutions. Fisher's exact test shows that there was a significant difference between the perceptions of students and lecturers in the first item. 94.4% of lecturers perceived that students' learning experiences would get *a lot worse* or *worse* if the online teaching continues in the long term, whereas this percentage was lower for students (i.e., 62.4%). Regarding the second item, similarly, 94.4% of lecturers had a concern about students' learning outcomes, whereas that percentage was lower for students (i.e., 64.1%). Looking at the descriptive statistics shared in Table 10 one might conclude that some students had positive perception toward online teaching as 21.4% of students chose *improved moderately* or *improve a lot* in responding to the first item, and 14.5% chose these two options in responding to the second item. However, no lecturers chose these two options in responding to the second item.

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Table 9

Items	Category	Not at all	A little	Some	Very much	I prefer not to	Fisher's Exact
						comment	Test
1. Fear for myself and/or my family of	Students	36 (30.8%)	46 (39.3%)	20 (17.1%)	15 (12.8%)		
being infected by the virus.	Lecturers	12 (66.7%)	5 (27.8%)	1 (5.5%)			.028
2. Losing physical contact with family and	Students	39 (33.3%)	35 (29.9%)	21 (18%)	22 (18.8%)		.176
friends.	Lecturers	8 (44.4%)	7 (38.9%)	3 (16.7%)			
3. Distractions of family and working at	Students	33 (28.2%)	39 (33.3%)	26 (22.2%)	16 (13.7%)	3 (2.6%)	.836
home.	Lecturers	7 (38.9%)	6 (33.3%)	4 (22.2%)	1 (5.6%)		
4. Absence from workplace and	Students	33 (28.2%)	32 (27.4%)	26 (22.2%)	23 (19.7%)	3 (2.6%)	.278
colleagues.	Lecturers	3 (16.7%)	10 (55.6%)	3 (16.7%)	2 (11.1%)		
5. Uncertainty about the future for myself	Students	51 (43.6%)	31(26.5%)	17 (14.5%)	16 (13.7%)	2 (1.7%)	.089
and/or my family.	Lecturers	13 (72.2%)	5 (27.8%)				
6. Depression.	Students	62 (53%)	27 (23.1%)	14 (12%)	9 (7.7%)	5 (4.3%)	.695
	Lecturers	13 (72.2%)	3 (16.7%)	2 (11.1%)			
7. Financial issues for myself and/or my	Students	67 (57.3%)	26 (22.2%)	15 (12.8%)	7 (6%)	2 (1.7%)	NA
family.	Lecturers			Not applicable			

The psychological impact of lockdown on student learning and lecturer teaching

Table 10

Perceptions of participants on the consequences of online teaching in the long term

ltems 0		Category	Get a lot	Get worse	No change	Improve	Improve a	No idea	Fisher's Exact
			worse			moderately	lot		Test
1.	Students' learning	Students	20 (17.1%)	53 (45.3%)	13 (11.1%)	20 (17.1%)	5 (4.3%)	6 (5.1%)	.099
	experiences	Lecturers	6 (33.3%)	11 (61.1%)				1 (5.6%)	
2.	Students' learning	Students	25 (21.4%)	50 (42.7%)	20 (17.1%)	13 (11.1%)	4 (3.4%)	5 (4.3%)	.131
	outcomes	Lecturers	6 (33.3%)	11 (61.1%)				1 (5.6%)	
3.	Prospects for the survival	Students	21 (17.9%)	30 (25.6%)	10 (8.5%)	6 (5.1%)	4 (3.4%)	45 (38.5%)	.379
	of smaller institutions	Lecturers	1 (5.6%)	4 (22.2%)	2 (11.1%)	3 (16.7%)	0	8 (44.4%)	