

Experience Report: Challenges and Opportunities of Remote Labs for a Computer Science Department

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Abstract

In response to the COVID-19 pandemic, the authors – the Graduate Teaching Assistant (GTA) Working Group of the School of Computing Science at a Scottish University - were involved in implementing changes to the delivery of lectures and lab sessions to continue the provision of labs and tutorials online according to government regulations and guidance. Such a drastic overhaul presented a variety of challenges when trying to preserve the student experience

and satisfaction. Here, we discuss these challenges, as well as the benefits and positive developments of online teaching.

Our approach tackled the difficulty of online-only interaction by reducing the staff-student ratio and providing a tiered support network for staff members to foster an effective teaching environment across the undergraduate program.

We reflect on our experiences and use evidence from GTA and student surveys to understand the impact of online only teaching. We examine possible explanations as to why students felt the new approach fell short before detailing the revised teaching methodology implemented in the 2021/22 academic session to address these limitations. With the phased return to face-to-face teaching, we were able to supplement online teaching with limited in-person labs. We utilised the limited in-person teaching to mitigate the shortfalls of online-only lab delivery by forming a hybrid approach, of which we explore both GTA and student survey responses. While the response to online learning was positive, the hybridisation was viewed less favourably. GTAs indicated that despite in-person teaching being the best solution, they preferred solely online classes to a hybrid approach.

Introduction

The COVID-19 pandemic has disrupted teaching throughout the education sector by leading to a rapid move to online teaching, distinct from a carefully considered and planned move (Barbour *et al.*, 2020). This global issue has contributed to a surge in literature covering several aspects of online education, including sharing practices, faculty readiness studies, and perceptions of new teaching implementations. While many of these studies focused on teachers (Atmojo & Nugroho, 2020; van der Spoel *et al.*, 2020), students (Coman *et al.*, 2020), and faculties (Cutri, Mena & Whiting, 2020), literature on Graduate Teaching Assistant (GTA) contributions to and perceptions of the transition to online teaching is limited. For example, Tinnion, Simpson & Finlay (2021) report on GTA perceptions of the transition from large to small group teaching and learning, although their paper only describes the teaching activities used to keep students engaged.

Our paper describes GTA teaching practices for undergraduate computing science courses in the authors' institution after imposed restrictions due to the COVID-19 pandemic. To this end, we aim to contribute to the knowledge of education during crises such as the COVID-19 pandemic, emphasising the perspectives and experiences of GTAs. We provide insights into the design process of new teaching practices and critically evaluate the changes made by considering their impact on GTA teaching experiences and effectiveness according to students.

The following sections provide some context to this work and explain the changes made to move all teaching online and later a partial reintroduction of in-person teaching. We later reflect on the process and impact of the move on teaching quality, according to GTA and student responses.

Context

The authors' institution has an approximate Computing Science (CS) undergraduate intake of 320, seeing roughly 250 students graduating in the current academic year. Students enrolled in CS participate in lab sessions, which are practical learning sessions supported by GTAs. Like other institutions, in response to the COVID-19 pandemic, teaching moved online for the academic year 2020-21, with preparation beginning early in the summer of 2020.

The authors of this paper form the School of Computing Science's GTA Working Group. This group — originally formed of GTA representatives (postgraduate students with GTA roles) and supervising administrative and academic staff — was convened to improve the experience and quality of GTA teaching for senior academic staff, GTAs and students.

In March 2020, when a state of pandemic was declared and restrictions began to be applied in UK institutions, the School of Computing Science established a separate working group for online readiness to prepare the School for imminent online teaching. However, this working group was predominantly formed of senior academics who were

focused on broader aspects of the shift to online learning with respect to content delivery; for example, investigating platforms for delivering online lectures, establishing guidelines for staff to follow to move their content online and providing guidance for the setting-up of exams.

The School's working group remit did not effectively capture the requirements for small-group teaching and did not have any GTA voices contributing to the discussion. Rather than adjusting the group's profile, the working group leaders requested that the already-established GTA Working Group adjust their focus specifically to designing a new best-practice framework for GTAs teaching online. This enabled the School working group to continue to focus on broader student and staff experiences while the GTA working group worked independently on small-group online learning. As such, this article is written by the team that formulated a structure – and later took part in the delivery of – GTA teaching during the pandemic.

COVID-19 Teaching Changes

In this section, we give some historic details of small-group teaching in the School of Computing Science and describe changes made due to the COVID-19 pandemic. We focus on labs, which are small-group teaching opportunities conducted in computer labs. In a typical lab, students are issued a task sheet related to some taught content that they work through under the supervision of a GTA. Some labs

have further specific expectations, such as group work or project presentation. However, the consistent expectation is that students are involved in some practical (mainly programming) activity while GTAs answer questions and supervise their work.

Practices Prior to COVID-19

Before the pandemic, CS labs were organised into classes of up to 25 students in Levels 1 and 2 and 70 in Honours¹ courses. GTA positions were only offered to master's and PhD students who self-reported sufficient experience in the module being taught. In some instances, module coordinators would request specific senior students by name if they had a particularly well-suited background, and these students would be given priority in the assignment of GTA roles.

Labs could last any length of time between an hour and a full working day. For example, Level 2 labs lasted either one or two hours, all Level 1 labs lasted two hours, and a particular Level 3 module had a lab session scheduled for a full day during which students were expected to work on team projects with tutors on-hand to support.

¹ The authors' institution is based in Scotland, where undergraduate degrees typically last for four years. The third and fourth years of study are referred to as 'Honours years' – colloquially and throughout this paper – as they contribute towards the final degree classification.

The number of postgraduate students employed as GTAs was below what would be required to have one per small group of students for each course: there were 27 GTAs (PhD students) to teach in the 2020/2021 academic session, and in semester 1, over 150 labs required GTAs for at least an hour each week. A GTA assigned three labs in a week would have over 10 hours of contracted teaching, which was the upper limit on what was deemed acceptable. Before the pandemic, staff numbers were also low, and GTAs were under growing pressure, stretched thin between teaching slots.

GTAs were categorised as *tutors* or *demonstrators*: tutors performed marking, assisted with all levels of courses and orchestrated the running of larger labs with multiple demonstrators; demonstrators assisted tutors in labs, and most demonstrators were final year undergraduates.²

Effect of COVID-19 on Teaching

No in-person teaching was permitted at the University in the 2020/2021 academic year. The available options for remote teaching were media delivery through the University's website, a Virtual Learning Environment (VLE, specifically Moodle), through Microsoft Teams or through Zoom. Lectures were moved online, with autonomy afforded to

² Therefore, the GTA acronym is something of a misnomer in this case (since most demonstrators are themselves undergraduates), but still a valuable categorisation because the experiences of these staff – graduate or not – are analogous.

module leaders over the choice of live or pre-recorded lectures (or a combination thereof). The format of practical small-group sessions was prescribed for all pre-honour's undergraduate courses (Levels 1 and 2) but only suggested for honour's and postgraduate courses due to the larger cohort size in pre-honour's years and the variability of requirements for pre-honour's teaching.

The principal motivation during the planning for online lab class restructuring was the reduction of group sizes to maximise the potential of effective online sessions, shrinking from 25 students per member of staff to no more than 10, as informed by existing research (Akcaoglu & Lee, 2016). This was expected to improve interpersonal communication, foster a sense of community and increase social presence.

We adopted Microsoft Teams for all content delivery, as this platform supported shared conversation history, long-term file sharing and configurable group setups, which was well suited to our planned lab settings. The format for practical sessions was consistent within each level and demonstrated to GTAs before teaching began. A requirement was set for all GTAs to have a stable internet connection, a working camera and an audible microphone, though logistically the School was not able to offer any support in acquiring necessary equipment.

The most significant change was having undergraduates teach other undergraduates. For classes at Levels 1 and 2, we employed students at least two levels above, e.g., Level 3 students taught Level 1 students, but could not teach Level 2

students. Prior to this, undergraduate students did not generally teach in the department, especially those in levels below Level 4.

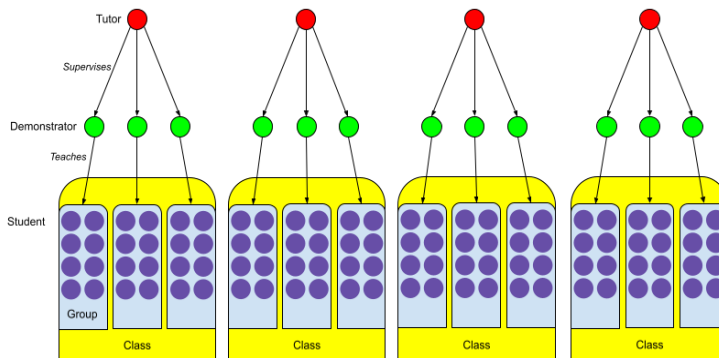


Figure 1: Visualisation of the structure of GTAs for teaching of courses at levels 1 and 2

The structure of practical sessions in Levels 1 and 2 is shown in Figure 1. Students were assigned a class of 15-25 students as before, but these classes were then divided into 3 groups with a demonstrator assigned to each sub-group. A tutor was responsible for the 3 groups in each lab and would move between concurrent meetings to observe, ensure appropriate teaching from the demonstrators and answer any questions that the demonstrator could not. This hierarchical structure was implemented to ensure both demonstrators and students were adequately supported.

Tutors were not explicitly trained on the management of demonstrators who reported to them. However, they were advised that it was their responsibility to highlight those they

felt were struggling with the course content or not engaging enough with the students.

We were not able to offer the same structure above Level 2 because we did not have the available GTA candidates with suitable experience. The structure for Levels 3 and above was to form groups in the same way but without a demonstrator, where peers supported each other, and tutors would move across the class groups to answer questions.

All classes in Levels 1 and 2 were shortened to an hour, where the majority had been scheduled for 2 hours previously. This change was motivated by reducing costs and minimising the fatigue associated with online learning (Behrens & Kret, 2019; Wiederhold, 2020). Students have always been expected to complete work outside of scheduled class time and arrive at labs with questions and difficulties they had encountered, so this change increased the need for student autonomy outside of the classroom as well as the need for tutor efficiency to deal with student questions within the time limit.

Therefore, in summary, the major changes to small-group teaching in the 2020/2021 academic year were:

Entirely online teaching through MS Teams

Smaller group sizes and shorter sessions to allow students more attention from GTAs and to avoid screen fatigue

More junior GTAs (demonstrators) recruited from undergraduate years

Adjusted lab structures for Levels 1 and 2 to increase the staff-to-student ratio in labs (which was only not employed in higher Levels of study due to a lack of available experienced GTA candidates)

Alternating blended teaching 2021/2022

Social distancing rules were eased for the 2021/2022 academic year, and schools were encouraged to offer some on-campus teaching. Due to social distancing, groups alternated weekly between on-campus and remote labs. It was believed that this would engender a sense of community through physical proximity and drive engagement in both forms (Kaur, 2016). On-campus labs were conducted as before the pandemic: one tutor and one demonstrator supervising a class of students. However, the lab sizes remained reduced.

Evaluation and Discussion

We investigated the effectiveness of implementing the new lab structures; separate online surveys were distributed to students and GTAs at the end of the first semesters of the academic years 2020/2021 and 2021/22. All surveys consisted of Likert type questions and open-ended questions. This section will examine the responses to the questions asked in these surveys and draw possible conclusions tempered with the potential limitations of our investigative approach.

The 2020/2021 surveys were designed to understand individual experiences of the online lab group environment. After the reintroduction of some in-person teaching for 2021/2022, additional questions were asked to compare experiences between fully online and hybrid teaching and to identify how well the School was able to address the issues identified in 2020/2021.

Each survey was analysed quantitatively by examining the proportions of responses to Likert and multiple-choice questions, and qualitatively by performing Content Analysis (Stemler, 2000) to identify major themes and the frequency at which they occurred in the responses.

2020/2021 Online Teaching Survey Results

The 2020/2021 surveys aimed to identify how our new lab structure helped mitigate the difficulties of a move to online teaching. The GTA survey received 28 responses, and the student survey received 307 responses³. Both students and GTAs were broadly in favour of the new lab structure (Table 1). When asked to identify what worked well in the online labs, several GTAs explicitly mentioned the subgroup structure (Table 2). For example, one GTA commented, “I believe splitting into subgroups is a great idea as it will help

³ Note that in some of the results the number of respondents is lower because respondents were not required to submit an answer for every question. This is particularly apparent in written responses, which many respondents left blank.

students communicate with each other and feel less isolated.” Further, GTAs felt the new lab structure encouraged students to “suggest solutions to other people’s problems” and “help each other with questions [...] has proven very effective as it is easier to learn from a peer”.

2020 Survey Respondents (n)	Lab group sizes are correct	Labs are positive, effective experiences
GTA (28)	88%	96%
Student (307)	94%	67%

Table 1: Summary of reported agreement with three statements posed to both GTAs and students in the online lab surveys (2020/2021)

Theme from GTA response	Count (proportion), n=28
Collaboration between students	7 (25%)
Practical examples discussed as a group	7 (25%)
Small groups, more demonstrators	7 (25%)
Ability to discuss problems asynchronously	2 (7%)

Table 2: Occurrences of themes in GTA responses to a question asking what they feel has worked well in online labs (2020/2021)

In support of this view of labs from GTAs, many students expressed positive sentiments: some stated that labs were the “best part of [their] uni schedule”, and many others expressed having “really enjoyed the labs”. Table 3 shows the students’ Likert responses. Overall, students reacted well to the increase in the number of GTAs and had a favourable view of their online lab experiences.

	<i>n</i>	1	2	3	4	5
Are you enjoying the lab sessions? (1 being "not at all" and 5 being "very enjoyable experience")	307	9%	11%	26%	29%	23%
How important do you believe labs are for your education? (1 being "not at all" and 5 being "very important")	307	4%	7%	17%	21%	52%
Do you feel you are adequately supported in the	306	4%	7%	19%	27%	43%

lab sessions? (1 being "not at all" and 5 being "very well supported")						
How comfortable are you asking questions or having a discussion with your group during the lab meeting? (1 being "not at all comfortable" and 5 being "very comfortable")	307	7%	10%	19%	25%	38%

Table 3: Proportions of student responses to Likert questions on their online lab experiences (2020/2021)

Both surveys identified some issues (see Table 4 for the issues students raised). Many GTAs found engagement in their small lab groups to vary significantly (see Table 5), with groups being described as “very passive” and students not making use of their microphone and camera. The student survey results showed that 53% of respondents only used their microphone, and 26% only communicated via typed messages (see Table 6). For improving lab interaction, students’ suggestions included getting GTAs to encourage camera usage and employing different lab formats that might

lead to more engagement. Both GTAs and students suggested increasing the duration of the labs.

Theme from Student response	Occurrences (proportion), n=140
General satisfaction	49 (35%)
General dissatisfaction	42 (30%)
Lack of interaction from other students	26 (19%)
Labs feel awkward or uncomfortable	13 (9%)
Labs are too short	12 (9%)

Table 4: Occurrences of themes in students' comments on remote labs (2020/2021)

Are the students engaging and communicating with you and their group?	Count (proportion), n=27
No engagement	0 (0%)
Limited engagement from a few students	6 (22%)
Some engagement from all students	12 (44%)
High engagement from a few students	8 (30%)
High engagement from all students	1 (4%)

Table 5: GTA responses to questions about how much engagement they typically experienced in labs (2020/2021)

In a typical lab, do you...	Count (proportion), n=307
Have camera on the entire time	44 (14%)
Have camera on sometimes	74 (24%)
Never turn my camera on but use my microphone	163 (53%)
Respond via text and occasionally use my microphone	81 (26%)
Respond via text and never use my microphone	10 (3%)
I attend but don't respond at all	12 (4%)
I do not typically attend labs	4 (1%)
Other	1 (0%)

Table 6: Students' responses to their most common methods of lab interactions. Note that students could select multiple responses, so the proportions are based on the number of students rather than the number of responses recorded.

2021/2022 Hybrid Teaching Survey Results

The 2021/2022 surveys aimed to understand the impact of employing a hybrid approach of alternating in-person and

online labs. The GTA survey garnered 47 responses. These responses presented a positive view of hybrid labs (see Table 7) despite a small proportion (2-7%) of respondents who indicated that both online and in-person labs were not at all effective.

GTAs preferred in-person teaching: 31% noted that they found students engaged more in in-person labs than they did online (see Table 8). One noted, “students are much more actively engaged [in-person], asking questions, working on assigned problems.” Some even suspected that students withheld questions during online labs for the following week when they could ask them in person.

GTAs identified more effective communication as another positive aspect of in-person teaching. One GTA remarked, “I can always see how a student is doing and [...] if they are present, I can ask to see what they are doing or how far along they are.”

	<i>n</i>	1	2	3	4	5
How effective do you find in-person labs (if applicable) this year? (1 being “least effective possible” and 5 being	43	2%	2%	9%	40%	47%

“most effective possible”)						
How effective do you find online labs (if applicable) this year? (1 being “least effective possible” and 5 being “most effective possible”)	44	7%	27%	39%	14%	14%

Table 7: GTAs’ Perceptions of the effectiveness of in-person and online labs during hybrid teaching delivery (2021/2022)

GTAs noted that online labs were relatively poorly attended when compared with in-person, with comments such as, “during online sessions my attendance drops, even though the online labs are theoretically easier to attend.” When asked about how they would improve this, three key suggestions emerged:

Inclusion of more “group [problem] solving skills” in labs, with tasks such as pair-programming, group worksheets, and discussions.

Adjustment of school policy to encourage more interaction and engagement, particularly on the use of microphones and cameras.

The use of alternative tools such as Gather⁴. It gives students more flexibility in who to interact with and opportunities to retreat to quieter spaces to work independently.

Overall, when not exclusively talking about online or in-person labs, GTAs comments were mixed. One response noted: “online labs are good [...] however, the in-person labs seem to get more practical work done versus the online ones.” Many GTAs reported that the hybrid teaching method improved their teaching experience, with common themes from their responses shown in Table 8. 32% of 44 responses in the 2021/2022 survey indicated a preference for a blended approach when asked which teaching method they would take forward post-pandemic. 9% preferred online-only learning, and 59% preferred a return to in-person teaching. GTAs had vastly more positive teaching experiences during in-person labs, as seen in Table 7, while the motivation for the hybrid approach was to improve student-GTA and student-student relationships; notably, few responses remarked on this explicitly. In this respect, hybrid teaching is positive insofar as it provides some in-person teaching, much preferred to online teaching. Future iterations of this delivery approach - when social distancing restrictions ease, thereby increasing in-person delivery capacity - might allocate

⁴ A 2D online videogame-style environment where participants move an avatar through a virtual space; as participants’ avatars get closer to each other, the platform uses the device’s camera and microphone to give the user presence (<https://www.gather.town/>).

individuals to either online or in-person labs to tailor labs to the individual better.

Theme from GTA response	Occurrences (proportion), n=47
Students interact more in-person	15 (31%)
Prefer teaching in-person	9 (19%)
In-person isn't always possible	7 (15%)
In-person feels more productive	6 (13%)
Both online/in-person have merits	6 (13%)
Participation is bad online	5 (11%)
Easier to see student progress in-person	4 (9%)
Online more approachable	4 (9%)
Lack of continuity with a hybrid approach	4 (9%)
Easier to encourage group work in-person	3 (6%)

Time allocation	3 (6%)
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Table 8: Occurrences of themes in GTA responses to hybrid learning when asked to compare online and in-person teaching (2021/2022)

Interestingly, when asked to rate their enjoyment of online labs, students reported enjoying the online labs substantially more in the online-only year of 2020/2021 than when labs were hybrid, as seen in Table 9. Similarly, they reported feeling more supported when labs were online-only. The full proportions of Likert responses used to generate these figures can be found in Table 3 for the 2020/2021 semester and **Error! Reference source not found.** for the 2021/2022 semester.

	2020/2021	2021/2022
Enjoyment of online labs	77%	56%
Enjoyment of in-person labs	<i>n/a</i>	74%
Support in online labs	85%	64%
Support in in-person labs	<i>n/a</i>	78%

Table 9: Mean scores of student enjoyment and perceptions of availability of support for online and in-person labs (2020/2021 and 2021/2022), where 0% represents no enjoyment or support and 100% represents the maximum possible enjoyment or support.

	<i>n</i>	1	2	3	4	5

Are you enjoying the online lab sessions? (1 being "not at all" and 5 being "very enjoyable experience")	108	27%	20%	17%	19%	17%
Are you enjoying the in-person lab sessions? (1 being "not at all" and 5 being "very enjoyable experience")	108	8%	10%	21%	27%	33%
Do you feel you are adequately supported in the in-person lab sessions? (1 being "not at all" and 5 being "very well supported")	108	5%	6%	24%	26%	40%
Do you feel you are adequately supported in the online lab sessions? (1 being	108	18%	15%	22%	22%	23%

"not at all" and 5 being "very well supported")						
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Table 10: Proportions of student responses to Likert questions on their hybrid lab experiences (2021/2022)

The most common theme in student responses in the 2021/2022 survey was that labs were much better in 2021. One student remarked: "I really enjoy getting to ask tutors in-person about my problems, and seeing them explain things is much better in-person," and another noted that "it is nice to have a dedicated working environment to focus on the lab." While 21% of student responses stated that they would prefer all labs to be in-person, 9% of responses stated that they would prefer labs were all online and 4% found it easier to get help when online. Other themes and their frequencies are listed in Table 11.

Theme from Student response	Count (proportion), n=68
Labs are better now	26 (38%)
Prefer all in-person	14 (21%)
Labs are worse now	11 (16%)
Easier to get help in-person	10 (15%)
Prefer all online	6 (9%)

Labs haven't changed	5 (7%)
I enjoy being on campus/in the lab	5 (7%)
Better discussion/explanations in-person	5 (7%)
Dislike travelling to campus	4 (6%)
Easier to get help online	3 (4%)
Social distancing limits effectiveness of in-person labs	3 (4%)

Table 11: Occurrences of themes from student responses when asked to compare labs this year to labs in the previous year (2021/2022)

One frequent suggestion from students was to include more collaborative work (see Table 12), already highlighted in the 2020/2021 survey, as a significant positive of online teaching. One student remarked that GTAs should encourage “students [to] work together on the problems when in-person.” From remarks in both years of surveys lamenting the lower level of collaboration during in-person labs, we can see that group work is something students enjoy and should be something GTAs can employ moving forward in both in-person and online labs. Indeed, this kind of group work has proven to be effective in a computing context (Porter *et al.*, 2011; Simon *et al.*, 2013) and has since been specifically adapted successfully within pandemic restrictions (Ala, Yang & Ala, 2021).

Theme from Student response	Count (proportion), n=109
More proactive GTAs	20 (18%)
GTAs encourage student collaboration	18 (17%)
More in-person labs	15 (14%)
More GTAs in labs	8 (7%)
GTAs should be more approachable	6 (6%)
Reduce social distancing restrictions	6 (6%)
Given the option of the type of labs to do	4 (4%)
Change length of online labs	3 (3%)
More online labs	3 (3%)
Make it easier to get support online	3 (3%)

Table 12: Occurrences of themes from student responses when asked how labs could be improved (2021/2022)

Limitations

Several limitations should be discussed regarding these findings. Both in 2020/2021 and 2021/2022, student feedback came primarily from Levels 1 and 2 - very few responses came from honour's students, which does not

allow us to evaluate in detail how honour's-level students have been affected by fully online and hybrid learning. This could be explained by the different lab structures of honour's courses since students did not have a fixed amount of time with a GTA for the duration of the lab. Additionally, honour's students have had the chance to experience in-person labs in their original format with a higher in-person staff-student ratio, so perhaps they found the transition more difficult.

As there was only a single survey in 2020/2021, we were not able to evaluate the effect of online learning over time. We would like to have identified whether online learning fatigue developed over the course of the academic year and how this may have affected the experience and effectiveness of online labs. We would have explored this by identifying whether the number of students not engaging increased or decreased and how online fatigue may have been reflected in how cameras, microphones, and virtual whiteboards were used.

Impact on GTAs and GTA Experiences

Aside from the perceived effectiveness of the shift to online teaching for GTAs and students, we also analysed comments from GTAs to detect any recurring issues regarding their experiences of teaching with the new system. Despite the significant upheaval, no substantial issues arose. GTAs appreciated the changes made and took to the new scheme well. Given the increased pressure and reliance on GTAs across the School, this is very encouraging.

We believe that many potential issues were avoided by using the GTA Working Group to redesign the format of online teaching. This group consisted of practitioners who were aware of many of the potential challenges in small-group teaching through experience, and in some cases through research. As such, the structure was created in a way that mitigated many of these expected issues. Furthermore, having experienced GTAs involved in organising the structure of GTA-led teaching was well received by the wider GTA cohort.

For example, prior to the pandemic there had been several instances of GTAs being unable to attend their teaching sessions at the last minute. Since many classes ran at the same time, the standard procedure to address this issue was for tutors teaching other classes in the same lab to take turns supervising the unattended class until appropriate cover could be found. This does not translate well to online delivery (where different users don't have access to everyone else's channels and chats in Teams), but knowing it was likely to be an issue, classes were designed to have extra GTAs to cover absences if required. Recall that in levels 1 and 2, each lab group had three subgroups, each supervised by a demonstrator, and a "floating" tutor to support as required. If a demonstrator was unable to attend, the tutor could step in to cover their group. If the tutor was unable to attend, the demonstrators could still work autonomously. This did mean that in both cases the tutor would not be available to move between groups and provide additional support to

demonstrators, but this was still a satisfactory temporary solution as all students did have contact with a GTA for the entire session. Since the GTA Working Group were aware of such issues through prior experience, we were able to improve the experiences of GTAs and students by designing our structures with consideration of circumstances we had encountered many times in the past, to avoid stress, panic and overworking our staff when failures did occur.

There were some recurring sentiments from GTAs identifying challenges faced. The main concern was the length of the online classes, with several tutors indicating that an hour was not enough time to deliver the content and they felt that they were rushing or leaving things out, generally increasing the stress of delivery. However, many GTAs also acknowledged that they understood the reason for reducing the session lengths (Zoom fatigue) and recognised the shorter delivery times as the "lesser of [two] evils". If online teaching is required in the future, we will consider different methods of delivery to allow us extra contact time with the students whilst avoiding Zoom fatigue. Alternative meeting software may be a route to achieving this, though more research and GTA perspectives are required.

Another unpleasant aspect of the GTA experience which was raised was unreliable peers and colleagues. Although these comments were far less frequent, some tutors indicated that the demonstrators didn't engage with their classes enough or came unprepared and some demonstrators indicated that their tutors didn't provide them with enough support.

Frustratingly for the GTA Working Group, this was a known issue that the group had originally been formed to address prior to the pandemic but had not been able to consider as focus moved to designing the new small-group structures. The issue was compounded by the move online due to the large increase in GTAs being employed without sufficient quality checks or continuous reporting solutions and the reduced serendipitous access to CS staff (e.g., catching a lecturer at the end of their session to ask a quick question). With new structures designed and mostly running smoothly, the GTA Working Group can begin to focus on these issues again to improve the experiences of staff and students. However, the increased interaction between GTAs and undergraduate demonstrators may have contributed to the increased reporting of concerns.

In summary, we did not observe any major negatives relating to the GTA teaching experience with the new online model. We believe that this is largely due to our School having a proactive, formally organised group of GTAs who were given a voice and a platform to share their experiences and assist in the move online. Minor concerns were mitigated by the increased representation of GTAs in the planning of delivery and, particularly in the first academic year of remote delivery, an acceptance that circumstances were difficult.

Reflections and Recommendations

To address some of the shortcomings of online labs, a hybrid design was adopted during the academic year 2021/2022. While we hoped the hybrid approach might resolve some of the issues outlined by students and GTAs previously, the 2021/2022 surveys showed a more nuanced view. Based on previous evidence, we expected the in-person labs to foster a sense of community and improve the dynamic of the online sessions. However, students seem to either prefer only online or only in-person labs. Reasons for this varied from getting better support during in-person labs to avoiding commuting. It may be possible to provide both forms of labs – entirely in-person and entirely online – and allow students to self-allocate according to their preferences. However, we recommend that such a strategy require close monitoring to ensure that students in each lab are afforded equal opportunities regarding the level of support and access to teaching staff.

The lower scores on support and enjoyment for the 2021/2022 lab sessions – in both delivery methods – could be attributed to several factors. Firstly, the initial survey was carried out in semester 1 of 2020/2021 at the outset of online teaching and before an additional year of online fatigue. Another potential factor is that students may have used this survey to indicate their preference for in-person labs, thereby deliberately lowering their ratings for online labs. Also, based on student responses to the 2020/2021 surveys, a non-trivial number of students indicated that

computing labs were the best organised and most effective of any of their online learning sessions in other courses, perhaps positively skewing the results in 2020/2021. Despite this, the result is surprising since we expected the hybrid model to achieve the best of both worlds, so this should be examined in more detail in future work.

A major suggestion from students and GTAs was to integrate more collaborative work: this is practically possible with appropriate online tools which allow live collaboration, such as shared whiteboards, documents and even development environments. However, the effective use of online tools will likely require additional training for GTAs. Nonetheless, the most substantial barriers to introducing more collaborative work are likely to be the course content itself, which GTAs rarely have control over. While resources are available to encourage and support collaborative work (Simon & Cutts, 2012), the responsibility remains with academic staff to implement changes.

When running hybrid labs, ensuring students can work in the same dedicated small groups both online and in-person might improve their experience. As pointed out in the 2020/2021 survey, students enjoyed working together and explaining problems to each other. Perhaps, designing more exercises where this could be applied in the in-person setting whilst adhering to some physical distancing will improve the social aspect of both lab sessions, and students will not feel like they are only talking to GTAs. Due to the tier structure of the labs, it is possible to introduce some 1-1s in most

sessions to allow students to feel better supported, which may improve the levels of support that were deemed to be low in the 2021/2022 labs.

The GTA Working Group was established following the initiative of GTAs themselves to address concerns about professionalism and welfare of GTAs in the School. Progress was being made in this regard, and we encourage other institutions with a comparable GTA contingent to consider similar processes. Our work is ongoing: this is a continuous process which was paused by necessity but has since been resumed and will continue to operate for as long as GTAs are employed by the School. We have been able to survey the appraisals from GTAs of the new teaching framework, which were largely positive, but have not yet been able to specifically evaluate the welfare of GTAs in this system. We also feel that many challenges which could have been faced by GTAs during the pandemic – Zoom fatigue, poor platform design, etc. – were side-stepped by allowing this group to provide important insights to the development process of the online teaching strategy. We would encourage any School or College to formulate their own groups of experienced GTAs to support their faculties and ensure that GTA voices are being heard in the decision-making process.

Conclusion

In this paper, we have described how we adjusted our lab teaching during the COVID-19 pandemic. We have provided

our reasoning and backed up our changes where appropriate. We have provided detailed insights into GTAs involved in teaching and students who experienced it. Some of our changes, including increasing the number of staff available and reducing the time spent in practical sessions, were well received. Others, such as transitioning to hybrid teaching, were not universally appreciated.

The purpose of this article is to share the experience of moving a large, varied cohort to online small-group teaching from the perspective of a group of GTAs. While our move to online teaching and subsequent hybrid teaching was effective, there are clearly lessons to be learnt and more work to be done. Our hope is that by sharing these experiences we can begin to develop a community of practice among GTAs beyond our institution.

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