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Facilitating peer-led group research through virtual collaboration spaces: an exploratory research study

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Peer-led group learning is a variation of collaborative learning and is based on 'small groups of students meeting regularly with a peer – one who has additional expertise in the subject matter – to work on problems collaboratively' (Pazos, Micari, and Light 2010). In this study, we explored how a Slack team environment could be used in a blended course design to support students working remotely on individual research projects, helping them in collaborative trouble-shooting and problem-solving activities with their 'near peer'. We drew on lessons learned from an initial trial (2017–2018 cohort) to inform a revised peer-led research design (2018–2019 cohort).

Our findings demonstrate the potential of collaborative platforms such as Slack to support near-peer learning, providing distinct channels for questioning, ideas sharing and agile problem-solving support in response to individual queries. The peer-led support contributed to high levels of engagement with the project work and deeper learning, helping less confident students to learn from group members and achieve positive outcomes in their own project work. We discuss the necessary conditions for effective peer-led learning to take place within a virtual space – identifying the clear communication of instructional roles, socialisation of students and responsiveness of near peers as factors influencing the adoption of the targeted learning methods – which we addressed in our revised peer-led design.

Keywords: near-peer mentoring; collaborative learning; team environments

To access the supplementary material, please visit the article landing page

Introduction

Peer-led group learning as a variation of collaborative learning has become widely adopted in science, technology, engineering and mathematics (STEM) disciplines as a way of supporting research tasks and the development of problem-solving skills (Wilson and Varma-Nelson 2016). This learning approach is based on social constructivist principles of knowledge building through interaction, involving 'small groups of students meeting regularly with a peer – one who has additional expertise in the subject matter – to work on problems collaboratively' (Pazos, Micari, and Light 2010). It represents a departure from teacher-centred instruction, offering students

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the space to manage their own learning and develop higher-order skills relevant to future employment and lifelong learning (Evans and Cuffe 2009).

This instructional approach is commonplace in campus-based laboratory work at the University of York, with near-peer demonstrators and academic staff on hand to guide and provide additional practical advice to students on how to perform research tasks. Indeed, in longer practical projects such as those undertaken by final-year students, participants are embedded in a research lab to individually investigate scientific questions. Here they are encouraged to share protocols with each other in small groups and obtain practical advice from postgraduate and postdoctoral members of the lab, as well as discussing how to interpret and improve their results. With a greater emphasis on flexible learning within our institution, we were interested in exploring how this near-peer learning approach could be supported remotely for 'dry' research tasks conducted outside the lab using online learning methods.

We begin this article with a review of the literature on peer-led group learning and the reported outcomes associated with this collaborative learning method. We consider the literature on online support for peer-led learning and related collaborative learning approaches and the technology that has been employed to support these methods, before going on to describe a blended peer-led design for bioinformatics research that we introduced at the University of York.

Literature review

Peer-led group learning

In STEM disciplines, students are often divided into small groups to perform a task collaboratively, providing them with an opportunity to share and discuss ideas, knowledge and skills. Peer-led group environments are typically characterised by high levels of student participation and interaction and problem-solving, which are encouraged through light-touch interventions by a facilitator responding to questions raised by the group (Pazos, Micari, and Light 2010).

Research on peer-led learning has highlighted the role of the near peer or peer leader in providing guided facilitation in team working environments (Quitadamo, Brahler, and Crouch 2009). Typically, this role is performed by a student 2–5 years ahead in their learning (Evans and Cuffe 2009), who has some expertise in small group facilitation and tutoring and a commitment to supporting flexible learning, rather than a subject matter expert who is directly involved in instructional activities.

Near-peer mentoring is reported to increase the interest and engagement of students, as well as contributing to the personal, educational and professional growth of mentors (Tenenbaum *et al*. 2014). Tien, Roth, and Kampmeier (2002) in a longitudinal study of an undergraduate organic chemistry course have reported significant improvements in student performance, retention, and attitudes for individuals who experienced a peer-led team learning instructional approach. Guden and Bellen (2020) in their study of the literature on peer-led learning in STEM disciplines found that participants performed better than those in a control group, demonstrating enhanced critical thinking skills and a better understanding of their subjects than those students who had not adopted these study methods.

Online support for peer-led group learning

Whilst this form of collaborative learning is well established in campus-based teaching contexts (Anderson *et al*. 2015; Zaniewski and Reinholz 2016), little is known about how we promote peer-led group learning through the use of collaborative learning technologies for students who are not co-located in a lab or work-based setting (Smith *et al*. 2014). Of the most recent studies, Jeong *et al*. (2020) have explored how peer teaching and interactive virtual learning in health sciences education may be supported by using peer teachers, although impact data on this approach have not yet been published.

There is, however, a rich seam of literature on computer-supported collaborative learning (CSCL) (Dillenbourg, Järvelä, and Fischer 2009; Lipponen 2002), which demonstrates how technology may be used to mediate active and collaborative learning where students work cooperatively to research and find answers to problems (Chen *et al*. 2018). There is also a related body of literature on peer assistants and their role in supporting group learning. Murphy *et al*. (2005) have proposed a framework building on the teaching teams model developed by Stover *et al*. (2000), comprising the instructor, teaching assistants and undergraduate facilitators who act as role models to their peers. This model is a reciprocal framework for online discussions, which provides scaffolding for students to become facilitators of learning and suggests creative ways for online instructors to manage different types of teaching responsibilities.

Technology platforms to support group-based learning

Chen *et al*. (2018) note that a variety of technology-mediated learning environments have been developed over the years to support learner engagement in carrying out collaborative tasks, ranging from online discussion tools to adaptive or intelligent systems and virtual learning environments. Studies on CSCL initially explored computer-mediated communication such as discussion forums to promote group discussion (Walker and Arnold 2004; Fischer and Mandl 2005). This progressed to a study of virtual environments (e.g. digital games, virtual reality and computer simulations), which were deployed to promote conceptual learning, problem solving and learners' engagement and motivation (Yang 2015).

More recently, we have observed the emergence of social media sites and collaborative social learning platforms such as Edmodo, followed by a new generation of team-based collaborative technologies: team-oriented sites (e.g. Google Sites), collaborative apps development and application projects led by students on behalf of external clients (Gan, Menkhoff, and Smith 2015). Of this new genre, we have seen the increasing adoption of team-based platforms such as MS Teams for collaborative work within UK higher education (Voce *et al*. 2021), combining the conferencing and messaging features of social media with file sharing and searching capabilities as part of an integrated, cross-platform solution. Team-based platforms represent a new industry-standard way of working online, with the scope to support individual and collaborative research tasks within a shared virtual space.

In this article, we explore how peer-led learning project work may be supported remotely as part of a blended learning design, drawing on the affordances of a team-based platform – Slack. Our exploratory study investigates the experiences of final-year life sciences undergraduate students at the University of York, who were exposed to this learning design for the first time in their programme in support of bioinformatics research tasks.

Background to the study

Final-year undergraduate projects in the Department of Biology are independent assignments spanning 16 weeks. Students are expected to carry out their own research and data analysis, with guidance and support from academic and other relevant members of the department. Students select topics based on a catalogue of titles and short project descriptions and are assigned one of their choices. Committing the equivalent of about 2 days per week to their project work, they are expected to generate their own data or analyse existing datasets, with the aim of producing a written report for assessment. Supervision of these projects is often delegated to another member of the lab (such as a graduate student) who has expertise in the techniques being employed in the project.

In addition to lab-based projects, students are offered bioinformatics topics for their extended project work. Our own bioinformatics projects relate to the characterisation of microbial genomes. Students are provided with large datasets and tasked with mining these data in a variety of ways to gain insights into the potential biological functions encoded in this information. Many of the tools required for this work rely on Unix-based open-source bioinformatics tools hosted on a remote server. Interacting with and manipulating data in this environment is essentially new to our undergraduates at the start of the project. As part of their project work, students identify the tools that best fit their research focus. This 'dry' research work can be conducted in any location with good Internet access. Typically, students are not required to be co-located for this work (Figure 1); this restricts the opportunities for collaboration and team-working that they might experience during a lab-based project, which are

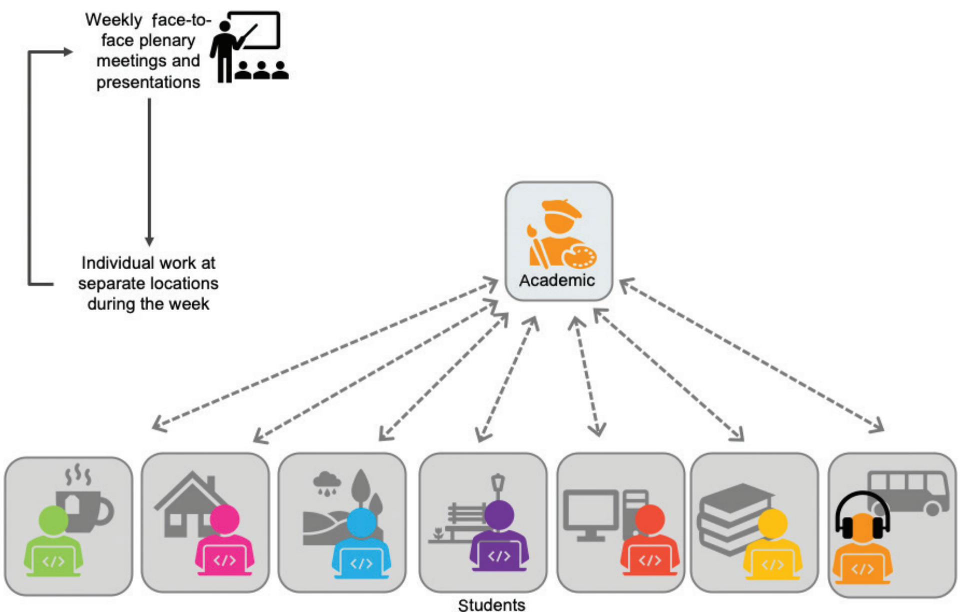

Figure 1. Traditional teaching model for 'dry' lab projects. An individual academic has one-to-one interactions with individual students who work independently on project work. This may be supplemented by weekly plenary meetings.

viewed as key transferable skills that students need to develop as part of their professional skills development (Fahnert 2015; Lategan 2016). Traditionally, collaboration has been hard to realise, with students working independently using different tools to analyse their data – often resulting in them getting stuck in different places, sometimes for significant amounts of time for trivial reasons such as syntax errors. This can lead to frustration, with students having to schedule meetings or rely on individual email discussions to resolve issues and move forward with their project work.

Introducing peer-led group learning to research projects

To address student engagement in knowledge-sharing and trouble-shooting on technical aspects of dataset analysis, we redesigned the project work for our 2017–2018 cohort of six project students. The revised approach introduced a peer-led group design to their research activities, providing one near-peer postgraduate research student to facilitate students working remotely on data analysis tasks. Students were briefed that the near peer was familiar with the Unix environment and could support them with programming issues. We hoped that by encouraging students to work collaboratively with their near peer and fellow researchers, they would assume responsibility for managing their own learning, rather than seeking assistance from academic staff, and could carry out this work remotely. In this way, the students could gain experience of the type of team-working and time management that they might encounter in a professional laboratory environment.

To support this approach, we introduced a blended design to project work. This was based around the use of industry-standard collaborative tools for remote study, enabling students to work at their own pace from any location in the undertaking of their research activities. We provided them with access to a shared Google team drive as a repository of project information, results and supporting literature. We also provided them with access to Slack (https://slack.com/intl/en-gb/) – a departmentally managed collaboration platform with dedicated team channels. Slack offered students the opportunity to share their research results in an instant and informal conversational manner through the supported messaging channels and file-sharing toolset within a secure environment. The platform also generated alert ‘push’ notifications for new messages – incorporating one of the key capabilities of social media within an integrated, cross-platform solution. We felt that this feature would help to support the spontaneous information sharing and trouble-shooting behaviour that typically occurs in labs, which we wished to replicate within the online environment. Whilst we did not set any participation standards for Slack, the platform was presented to students as the preferred location to ask and answer questions.

With secure access to bioinformatics tools, hosted on a computing cluster via a virtual private network, the project work could be undertaken almost exclusively off-campus. The only expectation was that students would attend weekly face-to-face group meetings on campus (1–2 h per week) with the near peer and academic staff. These meetings were used to monitor student progress, during which students presented and discussed their data, raised questions on the project work and discussed research papers as part of a journal club. All other work (equivalent to 2 days per week) could be carried out at any location with an Internet connection. The flexibility of this blended approach was intentional, enabling students to manage their individual research projects in a way that suited them best.

Trial of the peer-led learning design (2017–2018)

The peer-led design was first introduced to a cohort of six project students in the 2017–2018 academic year, who had no prior experience of this way of working online. Only one participant had used Slack as a collaborative environment before the start of this course. Over the project, we observed a lot of instructional activity, but only limited peer-to-peer interaction taking place online, with much of the commenting focused on solving technical problems rather than discussing biological questions. In this iteration, we failed to clearly define the role of the near peer to the students, presenting her as another instructor.

Near-peer interactions were further confounded by the academic staff emphasising the technical challenges associated with the projects and being highly responsive to collaboration platform queries. Thus, despite encouraging these students to share the problems that they faced in their individual research with group members and the near peer, interactions were less frequent than we had hoped with a lot of direct messaging to academic staff, who were the most active users of the Slack environment.

Figure 2 reflects this behaviour, showing academic staff as the leading contributors to the environment in terms of total number of comments made; academics also accounted for the highest aggregate total of collaborative and critical contributions that we tracked within the system (see Supplementary Figures S1a and S1b). We noticed that the near peer contributed to resolving a number of questions posed by the students, but this help was limited by the scope of the original projects which did not match her expertise.

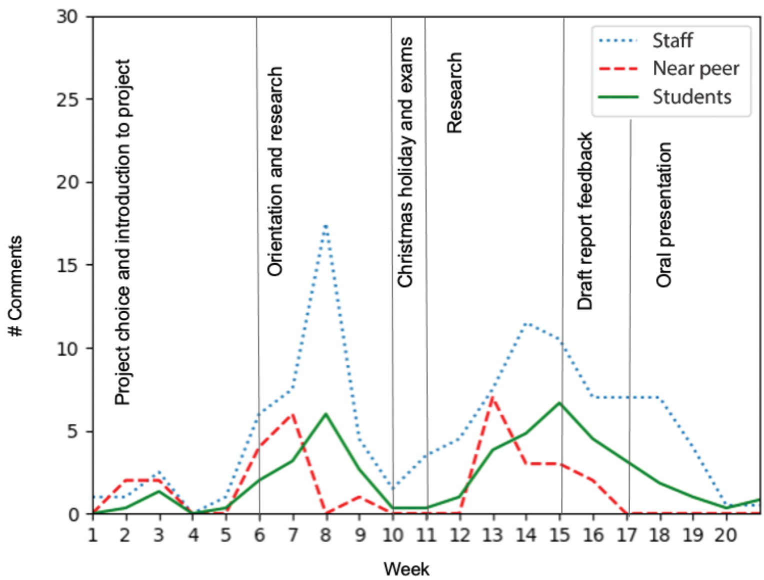

Figure 2. Weekly totals of comments by academic staff, the near peer and students in our initial study (2017–2018). Key phases of the project are indicated. Academic staff contributed most comments throughout the process, including many instructions during orientation and in support of research. The near peer contributed but was able to answer relatively few technical questions due to a lack of relevant project knowledge.

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Revised 'near-peer' implementation for 2018–2019 cohort

Using these learning points, we adjusted the project design by introducing two near peer postgraduate research students with more research expertise to the 2018–2019 cohort of seven students, who were each given their own dedicated channel within Slack to facilitate project work. We delegated further responsibility to the near peers by offering research projects in which they had direct expertise and could provide both academic and technical direction. We provided students with a free choice of one of three research topics (two led by near peers, one by academics) which resulted in an even division of the students between the groups (Figure 3).

The students were specifically instructed to meet their project 'adviser' (either a near peer or academic) within the Slack environment and use them as a first point of contact for queries and discussion between formal meetings of the whole group. Near peers were instructed to escalate questions and issues only if they were unsure of the correct response. All questions were considered to be valid and a specific emphasis was placed on experience sharing and collaborative troubleshooting, enabling students to analyse, assemble and annotate the provided genomic data.

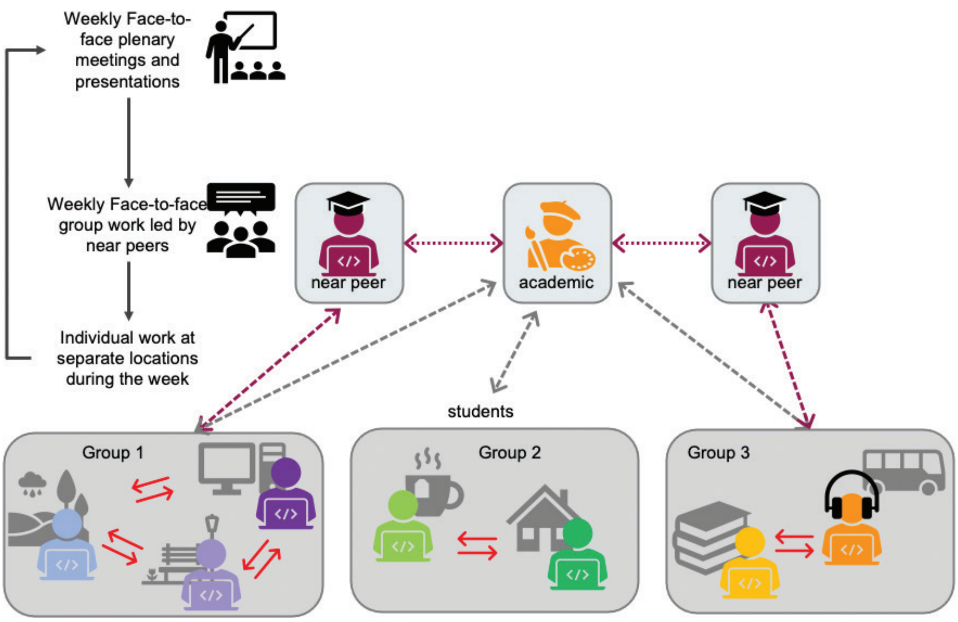

Figure 3. Revised 'peer-led' blended learning design for dry project work (2018–2019). Duration and number of instructional hours remained the same as in 2017–2018. From the cohort of seven students, three groups were formed with individuals assigned to groups based on their choice of project subject. Each group (consisting of three, two and two students, respectively) was linked to a near peer or academic based on subject expertise. A hierarchy was introduced: students would seek help from their group supervisor in the first instance, with the understanding that near peers would escalate questions to the academics where appropriate.

Research methods

This article presents findings from the delivery of the revised peer-led learning design to a cohort of seven UK and international students over the 2018–2019 academic year. In this exploratory study, we sought to gain a rich picture of students' engagement with the course design methods through a mixed-mode evaluation design, addressing two key research questions:

1. Can project students engage effectively in peer-led learning through a blended design approach?
2. How suitable is Slack as a collaborative platform in supporting peer-led group learning online? Specifically, what affordances do the Slack tools offer for knowledge-sharing and problem-solving for students who are not co-located in the conduct of research tasks?

Ethical approval was granted by the Department of Biology Ethics Committee for our research, which tracked students' use of Slack and their posts within the group channels of the environment. We measured student engagement by reviewing the weekly totals of comments within the Slack channels over the course of the project work, distinguishing between group and one-to-one messages to fellow students, near peers and academic staff, whilst also reviewing the different categories of contributions that were made by participants. We combined these data with focus group feedback to build a picture of how students made use of the Slack environment, which, in turn, provided insights into the suitability of the platform to support peer-led learning.

Evaluation approach

Evaluation focused on the nature of group interactions within the virtual space for peer-led learning. The unit of analysis for online contributions was a comment posted either within a near-peer group channel or the plenary channel of the Slack environment. A comment could contain multiple 'units of meaning' or categories of cognitive thinking within each post; it could be coded in multiple different ways based on the length and complexity of the message. To evaluate the comments, we used Fox and Mackeogh's 16 categories of cognitive thinking (Fox and Mackeogh 2003). This framework maps closely to the stated objectives for the peer-led learning in addressing evidence of self-directed research (sharing of resources) and of skills ranging from opinion forming (declarative statements) to higher-order cognitive skills (articulating and explaining, critiquing and challenging ideas of others).

Quantitative research methods were used to track the frequency of comments posted in each group Slack channel and the plenary channel. Each entry was assessed and coded twice by independent researchers. Discrepancies in coding were discussed and agreed. Coded data were analysed and results plotted using a custom Python script (see Supplementary Material for the code). Finally, focus group interviews were conducted by an independent researcher with students at the end of the course to probe their accounts of the learning that had taken place online. We subsequently combined the categories of comments that we had coded in groups to show different modes of participation, adapting a categorisation method on coding data developed by Rodriguez (2014). We collated the data from the coding of categories such as 'acknowledging contributions', 'offering resources' and 'asking questions' together to

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form a meta category for *collaboration*. We also grouped together the data from higher-order cognitive behaviours such as 'proposing actions based on developed ideas', 'supporting positions on issues' and 're-evaluating personal positions' to form a meta category for *criticality*. This was done to give a clearer picture of the communication activity that was being recorded in Slack and how it evolved over the 16 weeks that students were engaged in their project work. The breakdown of categories is presented in Supplementary Table A1.

Insights from this research have helped us to identify a set of conditions for effective peer-led group learning to take place within a virtual space, which are presented in the discussion section.

Results

Our tracking of engagement patterns between students, near peers and academic staff over the 16 weeks of project work (17 October 2018 to 15 March 2019) revealed three key phases of online activity, namely:

Phase 1 *(weeks 1–6)*: setting up and orientation: familiarisation with project work requirements, literature searches and transition to the near-peer study model
Phase 2 *(weeks 7–11)*: identification of bioinformatics tools and coding approaches and their application to project work
Phase 3 *(weeks 12–16)*: sense-making of coding output, including the review and write-up of research findings.

Interaction data (Figure 4) reflects the weekly totals of comments posted within Slack by students, near peers and academic staff. The graph shows the steady build-up of activity of the course from week 3 onwards, after students had received initial training on the project work and tools that they would be using in the opening weeks. There was a sharp drop-off in activity over the Christmas holiday period (week 8) and also in week 11, when students were busy completing data gathering activities before commencing the write-up of their findings, which led to a surge in messaging as students got to grips with sense-making of their data and identification of key findings.

Table 1 provides a breakdown of commenting activity for each student and displays the total number of messages recorded in the different Slack channels – distinguishing between group and one-to-one messages. The table reveals that participation levels varied between the three sub-groups, with the first two groups being the most active users of the group channels, whereas the participants in group three communicated far less together, with one student (Male 5) preferring to use direct messaging to the near peer rather than share ideas and questions within the group or general channels. Messaging activity and the type of messages posted varied between individuals for a number of reasons: time pressures (such as the stage of the project), priorities concerning how important an individual considered their question or comment and where students were on their individual learning curves:

> when you are new to this and new to coding and you are dumped with an unimaginable amount of data it can be quite overwhelming to start with … but I mean, we did make progress eventually, but it is two or three things, such a steep learning curve at the beginning. (Male participant 3)

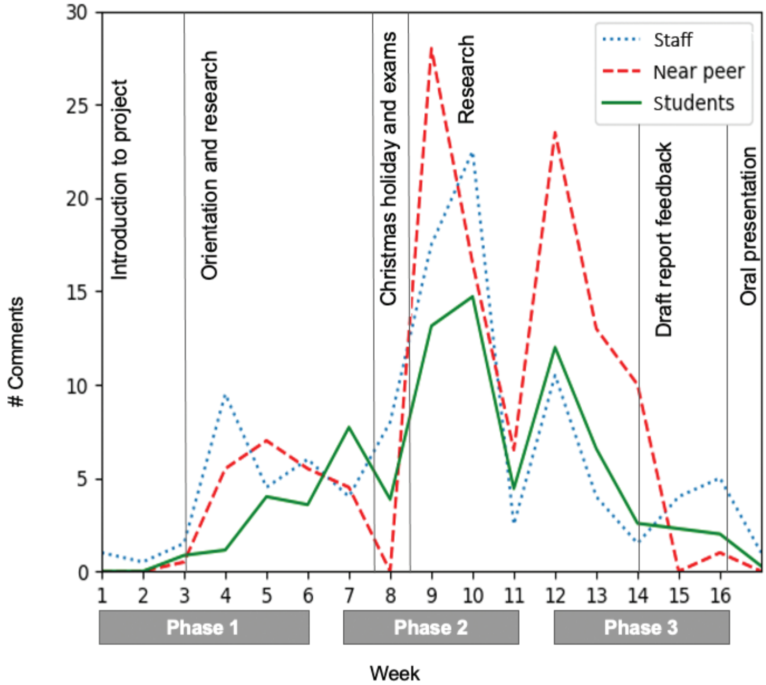

Figure 4. Aggregate weekly totals of comments by staff, near peers and students (2018–2019), displaying their *total interactions* within the Slack environment. In contrast to the activities observed in the previous year (Figure 2), the proportion of near-peer interactions greatly increased across the whole period. Academic staff were able to refocus their efforts into promoting thinking about biological interpretation during the research phase of the projects.

Table 1. Breakdown of commenting activity by individual participants via group and individual (direct messaging) channels within the Slack environment. Comments were classified as 'general' if they were addressed to the whole cohort, 'group' if they were posted to a specific channel within Slack and as 'one-to-one' if they were sent privately (and were therefore not visible to other users).

Participant/group	General communications	Group communications	One-to-one communications (to instructor)	One-to-one communications (to near-peer)
Male 1, Group 1	19	59	0	0
Female 1, Group 1	21	63	6	7
Female 2, Group 1	11	78	35	50
Male 2, Group 2	8	23	0	1
Male 3, Group 2	2	20	33	0
Male 4, Group 3	11	10	0	4
Male 5, Group 3	0	3	5	34

Students who made more rapid progress in their project tended to seek answers that were then of benefit to their peers when they reached the same point.

Phase 1 (weeks 1–6): setting up and orientation

Figure 4 shows how academic staff were the leading contributors to Slack at the beginning of the project, setting out parameters for research tasks and how students would work together. This was not entirely unexpected, given that the cohort had not conducted research tasks of this size in the first and second years of their study programme. The scale of the research task, the focus on bioinformatics and use of big data represented fresh challenges for the cohort. Additionally, the way that students were expected to work in near-peer groups was entirely new and required some adjustment by them in terms of their study methods. This involved a change in mindset from collaborative working in which group members all contribute to a shared project brief, to independent projects with individual accountability:

> … we are working as a group and can bounce ideas off each other, at the end of the day the work is ours … it is reflective of our efforts and our work … you have to perform as you are doing your own work. (Male participant 1)

These factors may account for the slow adoption of the Slack environment by students in the early weeks of research work, mirroring the same behaviour we had observed with the trial group (2017–2018), as illustrated in Figure 2.

Phase 2 (weeks 7–11): tools selection and application to project work

We observed a change in the usage of Slack midway through the project work during weeks 7–11, with near peers taking the lead in posting comments in their dedicated project channels. This marked a departure from what we had witnessed with the 2017–2018 trial group, with the 2018–2019 near peers and their project students far more engaged online. Each group had its own coding challenges, which required different learning curves – with some requiring detailed knowledge of Unix and command lines. We saw this reflected in a greater level of questioning from students and trouble-shooting during this period, which peaked as individuals made progress with their research.

Figure 5 shows how collaborative exchanges between near peers and students peaked during this period. The role of near peers was important in this phase of project work in helping students to make sense of the bioinformatics tool-set, guiding them on how the tools could be used in their research projects. The postgraduates had direct experience of using the data models and tools to support their own research and so had recognised expertise in these domains, as illustrated in the exchange between Near Peer 1 and students (Figure 6).

Phase 3 (weeks 12–16): sense-making of coding output

Figure 7 shows how the volume of critical comments peaked during this latter phase of project work, with near peers being the most active participants in the Slack channels. Contributions from academic staff dropped off during this period, with students

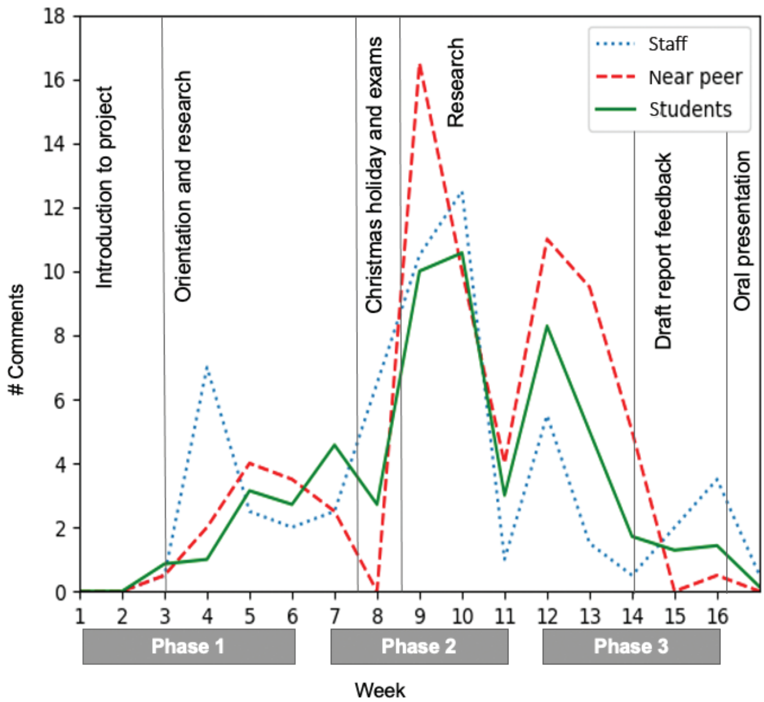

Figure 5. Aggregate weekly totals of *collaborative comments* by academic staff, near peers and students (2018–2019) within the Slack environment, revealing a significant number of contributions by students and near peers.

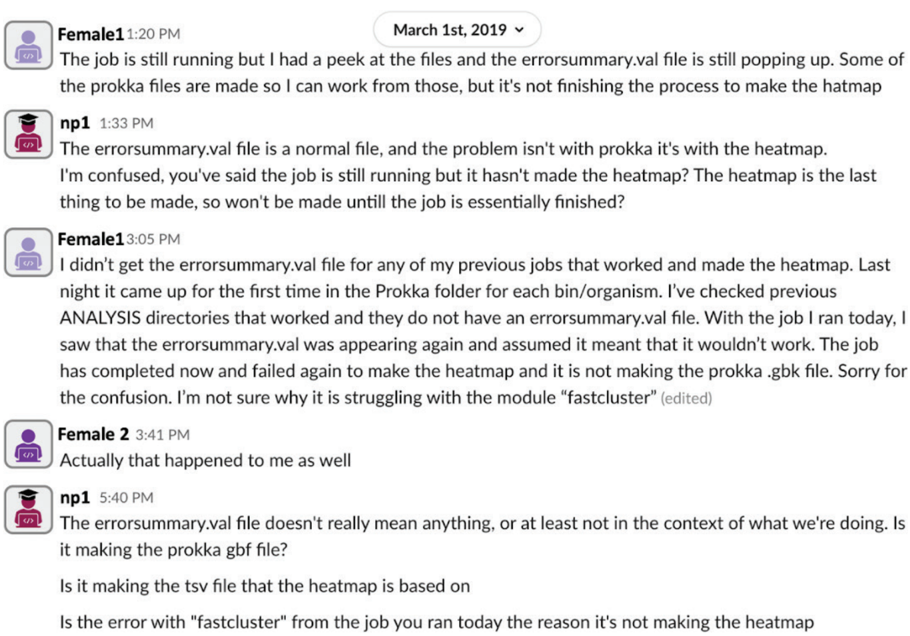

Figure 6. Screenshot of a collaborative exchange between Near Peer 1 and project students.

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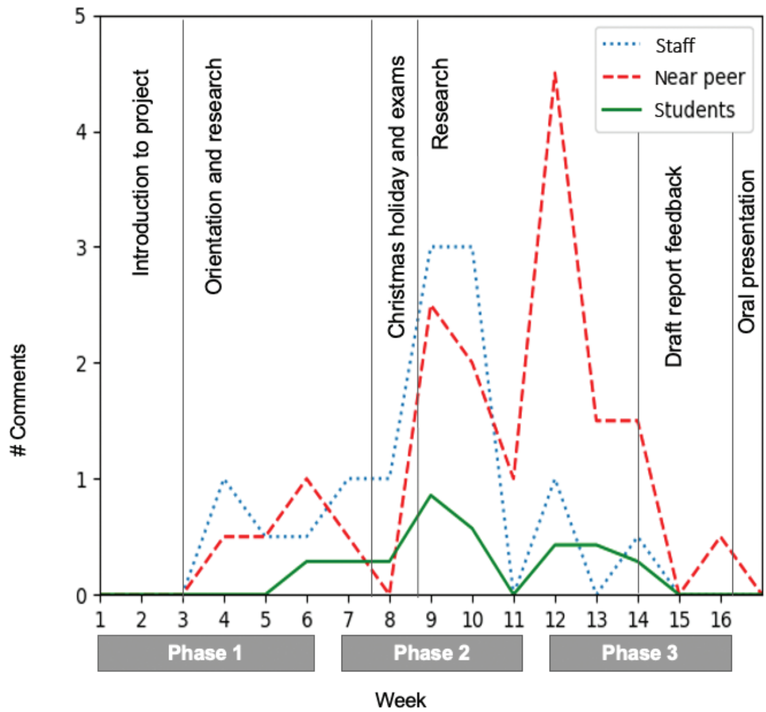

Figure 7. Aggregate weekly totals of *critical comments* by academic staff, near peers and students (2018–2019) within the Slack environment. Near peers were very active in promoting critical thinking by students as the research progressed.

and near peers the most visible in terms of messaging volume and the collaborative nature of exchanges. This review phase was characterised by sense-making of the coding output that participants had generated, with near peers facilitating discussion of results emerging from each individual research project. Figure 8 provides an illustration of a sense-making exchange between Near Peer 1 and project students.

Discussion – role of the collaborative environment in supporting peer-led learning

Our data for the revised design highlights how the 2018–2019 cohort engaged in information sharing and trouble-shooting within Slack as their project work progressed. The breakdown of commenting activity in Table 1 revealed how participation levels differed between individuals within project groups. We posit that this may be attributed to varying levels of confidence with the project work, as well as initial unfamiliarity with the supporting technology. This resulted in some students taking more time to engage with Slack and adapt to the peer-led learning approach for remote working:

> There were a lot of problems at the start getting everything running and it took a few months to get things sorted. I was battling with code and technology, when from a biological background, it was hard to get past at the beginning. (Female participant 1)

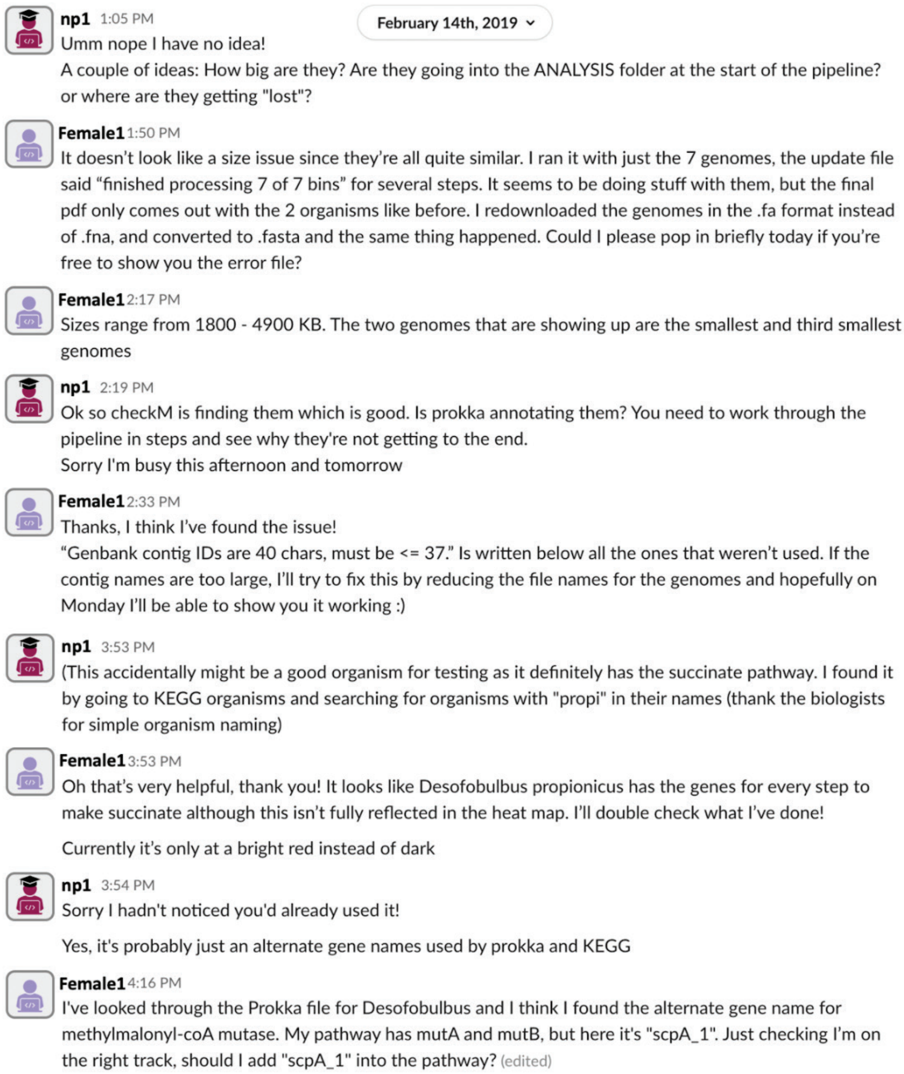

Figure 8. Screenshot of a critical exchange between Near Peer 1 and project students.

We observed that after the initial setting-up phase, interaction patterns increased in volume, with near peers assuming a key role in providing primary support to facilitate student learning. This enabled academic staff to assume a less prominent role in driving messaging activity and refocus their efforts on ensuring additional value from their supervision of the projects, for example, by using directed questions to encourage students to consider the implications of their results in the context of underlying biological principles. We also observed how students' posts evolved as the research projects developed, reflecting a greater level of criticality in the discussion of data and preliminary findings. These behaviours were consistent with our aims for the peer-led research work (**research question 1**), with participants engaged in knowledge-sharing and trouble-shooting on technical approaches to individual project work, as intended through our blended learning design.

Through focus group discussion, we sought to understand how these student behaviours were supported within Slack (**research question 2**) – considering the degree to which the collaborative tool-set matched the way that students wanted to work remotely. Over the project work, Slack was most commonly used by students for file-sharing and messaging. There was no formal induction on how to perform these tasks, as they were deemed to be intuitive:

> (Slack)'s very reflective of our generation – almost every type of social media platform you have these days has some sort of chat function in it. They all work pretty much the same, so it's just another phone, we can easily see how … you know how the buttons work because you've seen how everything happens before. (Male participant 1)

Participants viewed it as an ideal environment to highlight problems and to seek instant support from their peers at point of need:

> One of the things about Slack was that you could quite easily send screenshots across, so when we were talking to (Near Peer 1) for example, and saying I am getting this error and she says 'Can you send me a screenshot of this page?', and then you can and she can see exactly what is going on and you can get a very quick response on how to fix it, instead of having to battle with the code by yourself and get nowhere. (Female participant 2)

Students were encouraged to use it as a messaging service to post questions within both their group and the shared channels for all researchers to view. In this way, Slack replaced the private group chat tools that participants had been accustomed to using to manage their informal learning, such as Facebook Messenger and WhatsApp – offering a more inclusive environment which enabled all students, near peers and academics to take part in shared discussions:

> Lecturers and professors are part of that discussion (on Slack). It meant that we didn't have to send emails separately to them which is nice. (Male participant 4)

Slack was viewed by students as a more professional environment than social media sites to share progress and updates:

> Slack is slightly more formal than Facebook. It is about sharing things, rather than building a whole profile. Slack is more of a tool, Facebook is more of a site. The only reason to use Facebook would be to ask a stupid question which the lecturer can't see, but you can still do that on Slack through individual direct messaging to (the instructors) or someone else within the group. (Female participant 1)

Importantly, the environment also provided a searchable repository for all individual and group correspondence with a feed layout of messages – a feature not available in social media and email tools that students had used before:

> It is easy to keep a record of what's been said, whereas normally if you use G-Mail it's quite easy not to keep track of conversations, especially group conversations. (Male participant 2)

Indeed, the technology complemented our efforts to develop a sense of learning community between students, offering enhanced opportunities for shared learning both within and across the project groups – a point highlighted in the focus group feedback:

> I think we worked quite well as a group (with) different people making little subgroups based on the projects but also talking to each of us a whole, getting advice, or asking general questions. (Female participant 1)

This shared learning experience was perceived to be different from working practices in other 'wet lab' dissertation groups, '*where people don't really talk to anyone else in their group and work individually, having no idea if they are going in the right direction*'. (Female participant 1) The peer-led group learning was viewed as a supportive way of progressing individual projects:

> It kind of gives you the support that a group work gives you, because you have many other people to consult and to get advice from, but then it also pushes you to do your own work as you have to do your own work – it is dependent on you alone. (Female participant 1)

For less confident participants, engaging with the shared messaging and transparency of the environment was initially quite challenging. Individuals noted that they felt that it drew attention to their lack of progress whilst others got to grips with their project work. However, the affordances of the shared environment came to the fore later on in the project work, enabling them to search through previous messages for solutions that other participants had discussed and apply this shared learning to their own project work:

> (With Slack) If you want to find a message which was useful which was sent a month ago, it's easy to find it. (Male 2 participant)
> You may see someone makes a point or ask a question which at the time you don't think is relevant, but later on you can come back to it … actually I can probably make use of what that answer was … that will just spark something that you can look at. (Male 3 participant)

The ability to review previous discussions was deemed to be particularly useful by one of the less active project students, serving as a valuable reference point and stimulus for personal discussions with his near peer:

> … when I finally engaged with it, it was also an extremely useful resource. It saved time on common problems, highlighted important literature, and offered a method of communication with (Near Peer 2). This was useful as I was scared to ask questions publicly, but getting direct help and feedback from one person was a much lower psychological hurdle. (Near Peer 2) helped keep me motivated and was ultimately vital to me finishing my project. (Male participant 5)

This reflection highlights the observational learning activity that students were engaged in over the project and underlines its benefits for individual project work. It also indicates that the range and volume of communications in Slack were far greater than the interactions that we were able to track in the plenary and group channels, with direct messaging between individuals and near peers also taking place throughout the project work. This suggests that students were highly engaged with the project work and that Slack served as an effective location for shared learning to take place. In this way, the blended design enabled peer-led learning to flourish, despite the differences in the range of individual projects and the pace at which students progressed with their own research activities.

Factors influencing student reception of the near-peer learning design

Drawing on our experiences in designing peer-led project work and the combined data and student feedback from the trial (2017–2018) and revised (2018–2019) courses, we propose the following conditions which appear to influence student acceptance of the blended peer-led learning model:

Effective communication of roles and responsibilities: a clear demarcation of academic staff/near peer roles and responsibilities was communicated to students in the revised design during an oral briefing at the beginning of the project – correcting the blurring of roles from the 2017–2018 course. This was based on emphasising the close alignment of near peers' research expertise to the project briefs for each group. By explicitly acknowledging near-peer expertise and familiarity with the bioinformatics tools in the project brief and their group facilitation role, we provided a rationale for students to share issues within Slack project channels, rather than seek direct support from instructors. Students were strongly steered to use Slack rather than email and actively encouraged to join the relevant group channel as well as the general project channel. This appeared to encourage students to engage in peer-to-peer problem solving.

Socialisation of students to the peer-led learning model: greater attention to socialisation of students was addressed in the revised course, with the two supervising academics modelling use of the environment – directing questions and answers through the Slack channels, encouraging students to discuss and share findings with their near peer first before escalating issues to academics as part of the hierarchy model, with academics holding back responses to direct email requests for help. The attention to modelling aligns with previous studies that have demonstrated the impact of instructor behaviour on learner acceptance of new online study methods (e.g. Walker and Baets 2009; Webster and Hackley 1997). By establishing an agreed protocol for how students should use the shared environment, participants were encouraged to engage in a dynamic approach to problem-solving.

Effective facilitation of group learning: greater attention was paid to near peers' group facilitation responsibilities in the revised design for the 2018–2019 course. The highly responsive and supportive nature of near peer contributions within group channels was subsequently remarked upon by students, who reported that this was influential in their use of Slack, establishing it as a safe space to raise queries and share progress:

> You might ask a question on a Friday afternoon. If you had done that with an email, you wouldn't have got an answer back until the Monday afternoon. … Having that instantaneous linked response is nice ….We did not expect that. (Male 1 participant)

Students also highlighted how direct messaging to near peers could be used to test unformed ideas or questions, before sharing them with the wider project group.

This feedback underlines the importance of near-peer interventions in stimulating student interaction, encouraging less confident students to share ideas and issues within the collaborative environment and treat it as a safe space to do so, corroborating the findings of previous research studies (e.g. Smith *et al*. 2014). Our findings highlight the importance of near-peer preparation to help these more experienced students perform this role within a virtual space – echoing findings from previous studies of peer-led learning for campus-based courses (e.g. Evans and Cuffe 2009; Quitadamo, Brahler, and Crouch 2009) that have stressed the need for orientation on small group dynamics and learning theory. We may also draw parallels with the literature relating to online peer assistants (Murphy *et al*. 2005; Stover *et al*. 2000), which has highlighted the need for scaffolded training to help students become effective facilitators of learning, developing their group facilitation skills. Building on this research, our findings suggest a requirement for near peers to develop a conversational rather than directive mindset to assist students with the transition to peer-led learning methods.

Limitations of the research

Our research was exploratory in nature and conducted with a small group of students and without a control group. The emergent conditions for student engagement with the blended peer-led learning design that we identified have not been empirically tested, and we cannot point to a direct causal relationship between the changes made in the 2018–2019 design and the student engagement patterns that we observed. Control measures would need to be put in place to determine their impact on interaction patterns, focusing on variables such as group size and the number of available facilitators and instructors to support student learning.

Conclusion

Whilst acknowledging the limitations of this small-scale exploratory study, it represents one of the first to explore how peer-led learning methods may be supported through a blended learning design and specifically through the use of a team-based platform. The research is insightful in demonstrating the potential of Slack to support interaction and problem-solving in contexts where students are conducting independent research projects remotely. Cohort feedback highlighted the value of Slack's distinct channels for questioning and ideas sharing, with participants noting the impetus that 'push' notifications gave to highly agile problem-solving of individual project queries, which was facilitated by the more experienced postgraduate research students. This, we contend, led to better student engagement with project work and deeper learning, with all students moving on from discussing purely technical problems to asking more probing and reflective questions concerning their results as they made progress with their projects. All students successfully completed their assignments on time. We also observed how the collaborative design helped less confident students to learn from their peers and achieve positive outcomes in their own project work. Access to the records of peer, near peer and instructor problem-solving discussions provided easily accessible support for individuals who did not progress their projects at the same pace as the majority of their cohort.

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Given the current Covid-19 context (Marginson 2020; Rapanta *et al.* 2020), with restrictions on campus access to lab environments, a blended design approach presents an alternative and more flexible way of supporting students in the conduct of research tasks. Research projects can be conducted at a location and pace that suit individual students, and through facilitated support, they may be undertaken largely independently, with reduced dependency on the course instructor for guidance and control of the learning process. From an employability perspective, the design approach also encourages the development of transferable soft skills such as problem-sharing and problem-solving within groups, which are key to how professional lab environments work (Fahnert 2015; Lategan 2016). We suggest that both the design approach and collaborative technology may be transferable to other disciplines and teaching contexts beyond life sciences – helping students to acquire valuable problem-solving skills whilst actively engaging them in the learning process.

Future research directions

We intend to test the revised design approach with future cohorts, paying particular attention to the conditions for student engagement to assess whether these are determining factors in student acceptance of the targeted learning methods. This would also investigate group sizes as a variable for effective interaction with a near peer. We are also interested in applying near peer methods to different programmes and cohorts, including postgraduate taught students, to see how they may transfer to different disciplinary contexts.

We acknowledge that whilst this study explored the use of Slack as a supporting environment for near-peer learning, other collaborative technologies (e.g. MS Teams) could perform a similar supporting role and a future study could explore the affordances of different platforms and how they best complement this learning design approach.

References

Anderson, M., *et al.* (2015) 'Near-peer mentor model: synergy within mentoring', *Mentoring & Tutoring: Partnership in Learning*, vol. 23, no. 2, pp. 116–132. doi: 10.1080/13611267.2015.1049017

Chen, J., *et al.* (2018) 'The role of collaboration, computer use, learning environments, and supporting strategies in CSCL: a meta-analysis', *Review of Educational Research*, vol. 88, no. 6, pp. 799–843. doi: 10.3102/0034654318791584

Dillenbourg, P., Järvelä, S. and Fischer, F. (2009) 'The evolution of research on computer-supported collaborative learning', in *Technology-Enhanced Learning*, eds N. Balacheff, *et al.*, Springer, Dordrecht, pp. 3–19. doi: 10.1007/978-1-4020-9827-7_1

Evans, D. J. & Cuffe, T. (2009) 'Near-peer teaching in anatomy: an approach for deeper learning', *Anatomical Sciences Education*, vol. 2, pp. 227–233. doi: 10.1002/ase.110

Fahnert, B. (2015) 'On your marks, get set, go! – lessons from the UK in enhancing employability of graduates and postgraduates', *FEMS Microbiology Letters*, vol. 362, no. 19, pp. 1–6. doi: 10.1093/femsle/fnv150

Fischer, F. & Mandl, H. (2005) 'Knowledge convergence in computer-supported collaborative learning: the role of external representation tools', *Journal of the Learning Sciences*, vol. 14, pp. 405–441. doi: 10.1207/s15327809jls1403_3

Fox, S. & Mackeogh, K. (2003) 'Can e-learning promote higher-order learning without tutor overload?', *Open Learning*, vol. 18, no. 2, pp. 121–134. doi: 10.1080/02680510307410

Gan, B., Menkhoff, T. & Smith, R. (2015) 'Enhancing students' learning process through interactive digital media: new opportunities for collaborative learning', *Computers in Human Behavior*, vol. 51, no. part B, pp. 652–663. doi: 10.1016/j.chb.2014.12.048

Guden, J. & Bellen, J. (2020) 'A scoping review of the peer-led team learning to learner-participants and peer leaders in STEM courses', *International Journal of Research Studies in Education*, vol. 9, no. 5, pp. 1–13. doi: 10.5861/ijrse.2020.5008

Jeong, L., *et al*. (2020) 'Virtual peer teaching during the COVID-19 pandemic', *Medical Science Educator*, vol. 30, pp.1361–1362. doi: 10.1007/s40670-020-01065-1

Lategan, J. (2016) 'Enhancing employability through group work', *Microbiology Australia*, vol. 37, pp. 88–89. doi: 10.1071/MA16029

Lipponen, L. (2002) 'Exploring foundations for computer-supported collaborative learning', *Proceedings of the Computer-supported Collaborative Learning Conference*, Jan 7–11, Boulder, CO, pp. 72–81, [online] Available at: https://repository.isls.org/bitstream/1/3924/1/72-81.pdf

Marginson, S. (2020) 'Global HE as we know it has forever changed', *Times Higher Education*, March 26, [online] Available at: https://www.timeshighereducation.com/blog/global-he-we-know-it-has-forever-changed

Murphy, K., *et al*. (2005) 'A constructivist model of mentoring, coaching, and facilitating online discussions', *Distance Education*, vol. 26, no. 3, pp. 341–366. doi: 10.1080/01587910500291454

Pazos, P., Micari, M. & Light, G. (2010) 'Developing an instrument to characterise peer-led groups in collaborative learning environments: assessing problem-solving approach and group interaction', *Assessment & Evaluation in Higher Education*, vol. 35, no. 2, pp. 191–208. doi: 10.1080/02602930802691572

Quitadamo, I., Brahler, J. & Crouch, G. (2009) 'Peer-led team learning: a prospective method for increasing critical thinking in undergraduate science courses', *Physical Therapy Faculty Publications*, vol. 45 [online]. Available at: https://ecommons.udayton.edu/dpt_fac_pub/45

Rapanta, C., *et al*. (2020) 'Online university teaching during and after the covid-19 crisis: refocusing teacher presence and learning activity', *Postdigital Science and Education*, vol. 2, pp. 923–945. doi: 10.1007/s42438-020-00155-y

Rodriguez, M. (2014) 'Content analysis as a method to assess online discussions for learning', SAGE *Open*, vol. 4. no. 4, pp. 1–13. doi: 10.1177/2158244014559019

Smith, J., *et al*. (2014) 'Replicating peer-led team learning in cyberspace: research, opportunities, and challenges', *Journal of Research in Science Teaching*, vol. 51, pp. 714–740. doi: 10.1002/tea.21163

Stover, L. A., *et al*. (2000) 'The teaching teams program: empowering undergraduates in a student-centered research university', in *Student-Assisted Teaching: A Guide to Faculty–Student Teamwork*, eds J. Miller, J. Groccia, & M. Miller, Anker, Bolton, MA, pp. 40–43.

Tenenbaum, L., *et al*. (2014) 'An innovative near-peer mentoring model for undergraduate and secondary students: STEM focus', *Innovative Higher Education*, vol. 39, pp. 1–11. doi: 10.1007/s10755-014-9286-3

Tien, T., Roth, V. & Kampmeier, J. (2002) 'Implementation of a peer-led team learning instructional approach in an undergraduate organic chemistry course', *Journal of Research in Science Teaching*, vol. 39. no. 7, pp. 606–632. doi: 10.1002/tea.10038

Voce, J., *et al*. (2021) *UCISA Technology-Enhanced Learning Survey 2020*, [online] Available at: https://www.ucisa.ac.uk/TEL2020

Walker, R. & Arnold, I. (2004) 'Introducing Group-Based asynchronous learning to business education. Reflections on effective course design and delivery', *Educational Media International*, vol. 41, no. 3, pp. 253–265. doi:10.1080/09523980410001680860

Walker, R. & Baets, W. (2009) 'Instructional design for class-based and computer-mediated learning: Creating the right blend for student-centered learning', in *Applied e-learning and e-teaching in higher education*, eds R. Donnelly & F. McSweeney, Hershey: Information Science Reference, pp. 241–261. doi: 10.4018/978-1-59904-814-7

Webster, J. & Hackley, P. (1997) 'Teaching effectiveness in technology-mediated distance learning', *Academy of Management Review*, vol. 40, no. 6, pp. 1282–1309. doi: 10.2307/257034

Wilson, S. B. & Varma-Nelson, P. (2016) 'Small groups, significant impact: a review of peer-led team learning research with implications for STEM education researchers and faculty', *Journal of Chemical Education*, vol. 93, no. 10, pp. 1686–1702. doi: 10.1021/acs.jchemed.5b00862

Yang, Y.-T. (2015) 'Virtual CEOs: a blended approach to digital gaming for enhancing higher order thinking and academic achievement among vocational high school students', *Computers & Education*, vol. 81, pp. 281–295. doi: 10.1016/j.compedu.2014.10.004

Zaniewski, A. M. & Reinholz, D. (2016) 'Increasing STEM success: a near-peer mentoring program in the physical sciences', *International Journal of STEM Education*, vol. 3, no. 14, pp. 1–12. doi: 10.1186/s40594-016-0043-2