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Creating Communities of Learning via Academic Support: Scientists, Engineers and Mathematicians Don't Just 'Do' Equations

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Academic and mathematical skills development is built into the curriculum in all modules on the Engineering and Physical Sciences Foundation Year programme at a university in England, with all teaching team members involved including our Lecturer in Learning Development. Two specific academic support initiatives are outlined in this paper to provide a small-scale case study of approaches to developing learning communities. The first is a 'Peer-Assisted Learning Scheme' which involves the mentoring of groups of students by a previous Foundation Year student. The second is the 'Engineering Business Case' involving a group design project with a financial incentive supported by the Engineers in Business competition. In both cases, the student voice, through the lens of creating communities of learning, was sought through questionnaires. There are indications that both mentees and mentors reported benefits in terms of learning and development and engaging with other students in their participation with the Peer-Assisted Learning Scheme. For the Engineering Business Case a contrasting view was seen: whilst the students agree that components of this project were valuable for their learning and/or future studies, meeting new people, and developing strategies for group work, there were mixed responses about whether the project helped them to feel part of the student community. The data evaluated in this work do not lend themselves to any generalisations. Rather, we seek to report on the framework and implementation of these schemes which, as they mature, will lend themselves to more quantitative and qualitative data collection for interpretation.

Introduction

This paper expands on a presentation given at the Foundation Year Network Conference 2022 on the theme of c*reating communities of learning via academic support*. We share two examples of creating communities of learning via academic support within the Engineering and Physical Sciences Foundation Year (EP&S) Foundation Year (FY) programme at our University. The first is

a peer-assisted learning scheme, which involves FY students from previous academic years supporting current students in their studies. The second involves a student group project creating a business case for an engineering idea, with a financial incentive provided by the Engineers in Business competition. After contextualising these examples in our FY setting, we reflect on how they have helped develop communities of learning through academic support within credit-bearing modules.

The EP&S FY programme is an integrated year-long course that enables students who complete the programme to progress into an undergraduate degree course across a range of engineering and physical science subjects. The programme started in the 2018-19 academic year with a cohort of 50 students and now regularly welcomes 90-130 students each year. Most students are under 25 years old and, like many FY programmes, cohorts consist of a higher proportion than university averages from several widening participation backgrounds (Dampier *et al.*, 2019). At the heart of our programme is the philosophy of developing academic and mathematical skills for student success. As such, we ensure that opportunities to develop academic and mathematical skills are integrated across the taught FY curriculum to enable multiple authentic opportunities to reinforce skills development.

When considering a definition of the term *community of learning*, for this paper we are encompassing the social aspects of learning and consider 'communities of learning' and 'communities of practice' synonymously. There is a wealth of research and literature on this area that will not be explored fully here. Instead, interested readers are directed towards wider resources (Wenger, 1998, 2000, 2011; Li *et al.*, 2009; Hoadley, 2012). Briefly, in implementing the initiatives that are the subject of this work, the FY teaching staff embrace the value of the 'social constructivism' philosophy that learning is constructed from social experiences and not solely through individual cognitive processing (Fry, Ketteridge and Marshall, 2008; Jordan, Carlile and Stack, 2008). These social experiences for learning can include observation of role models leading to changes in behaviour (Bandura and Walters, 1977). Furthermore, peer-to-peer interactions are a key element for building a good learning experience, with active engagement being one of the premises underpinning Wenger's 'Communities of Practice' in his social theory of learning; "Knowing is a matter of participating in the pursuit of such enterprises, that is, of active engagement in the world." (Wenger, 1998, p. 4). The need for these 'social communities of learning' has been highlighted as valuable by students through times of social isolation when interactions were limited due to COVID-19-related restrictions (Neves and Hewitt, 2021). Developing such a community in the FY is thus desirable for learning, and hence supporting the development of this community is explicitly embedded in all the FY programme modules via academic support. Next, a definition of *academic support* for this paper: academic support in the FY encompasses the development of (academic) skills such as group working, active listening, critical thinking and approaches to work, presentation skills, scientific writing, managing and prioritising time, principles of academic integrity, assessment literacy, etc., through assessment of these skills in the context of engineering and the physical sciences. This is achieved through a teaching team that includes a Lecturer in Learning Development as well as subject specialist lecturers who together combine their experience and expertise to make pedagogically sound and authentic assessments.

Herein we discuss two distinct examples of creating communities of learning through academic support. The Peer-Assisted Learning Scheme and the Engineering Business Case group project are described, including their design principles and assessment, as well as the student reflections on being part of these learning communities. Despite some mixed responses about the student-perceived success of establishing such a community of learning (predominately in the business case example), there appears consensus that these endeavours are a worthwhile pursuit and can contribute to a community of learning. The limited data collected so far will help to incrementally improve these initiatives and provide readers with the framework for establish-

ing similar initiatives in their own context. As these initiatives mature, we anticipate further qualitative and quantitative data collection for evaluation to better understand these communities of learning.

The Peer-Assisted Learning Scheme (PALS)

The initial transition to the university learning environment is a key step for future success in the academic setting (Summers, Higson and Moores, 2021), and peer support can play a valuable role in helping with this transition (Chester *et al.*, 2013), especially via observation of those who have travelled a similar route in previous academic years. The transition phase should help with welcoming new students into the community of learning at the university as well as provide an additional informal pastoral support network. The University has a peer mentoring scheme designed to support academic writing and another to address the 'awarding gap' for some student cohorts. Both these schemes are 'opt-in', and, at the time of writing, no EP&S FY students had taken up this offer, despite students being signposted to the schemes at various points in their programme of study. As a response to this observation, we developed a bespoke version of the existing schemes, which we refer to as the Peer-Assisted Learning Scheme (PALS). This bespoke scheme addressed the transition to learning at university for the FY students in our cohort, with all students automatically enrolled as part of their compulsory academic modules. More specifically, the scheme was aimed at assisting students in preparing university-level assignments, managing workload, time management, organisation of notes, getting the most out of tutorials and with other practical advice about university life that peers can effectively and credibly share. Indeed, many of these learning aims are hard to teach theoretically. Rather, practical engagement in using the skill is critical to its development. Additionally, when we ask finishing cohorts, 'What advice would you give to next year's students?' these areas of learning are frequently mentioned by students.

The PALS was implemented in semester one of the 2021-22 academic year as follows. Current students (n = 95), *the mentees*, were enrolled on the scheme as part of a compulsory taught module (a computer programming module). The module leader assigned three to five of the mentees to a group, which was then allocated a *mentor*. An application process was set up to recruit suitable mentors from the wider EP&S FY alumni. This included eligibility criteria, an application form, an interview, and compulsory training. A recruitment email for mentors was sent out to all EP&S FY alumni to seek expressions of interest in this paid opportunity, with a link to the application form. Payment (in our case, administered through Unitemps) was important to improve the inclusivity of the opportunity, particularly in terms of increasing opportunities to participate, by making it both financially viable and CV-enhancing for those students who required part-time work to supplement the costs of their studies or lifestyle. The application form required prospective mentors to provide evidence of high academic achievement (>68%) in a piece of assessed work, and they needed to answer questions about their suitability, skillset, and motivation for joining the PALS. They also had to seek an academic reference to support their application. Short-listed applicants were then interviewed by members of the FY staff and the vast majority of those who completed these tasks were suitable for recruitment.

The successful applicants were required to complete bespoke training to help guide them through setting up, conducting, and recording meetings with their mentees. The PALS was underpinned by an in-depth handbook setting the expectations and requirements for engaging with the scheme. Whilst writing such a document can present a large undertaking (for example, this document was approximately 30 pages long) it provides a foundational resource throughout the PALS. Similarly, a Microsoft Teams channel was made, with mentors added, to give a place

for questions, answers and discussion between mentors and staff. Finally, mentors aimed to meet with their group(s) of mentees three times during semester one (approximately once a month) and were required to keep a record of meetings via an online diary. These records were important for quality control purposes as well as a feedback opportunity for mentors from staff and, as such, payment for mentoring was only made upon receipt of these records.

An evaluation of this academic support was undertaken to better understand how both the mentors and mentees found the experience, what they valued and whether it contributed to a community of learning in their eyes. This voice was captured through anonymous questionnaires which were distributed to all students involved in the PALS. Before any data collection, an ethical self-assessment by the researchers was completed which indicated a further review by a committee at the University was not required. All questionnaires were written within Microsoft Forms and distributed by email. In total, 7 responses were received from mentors and 20 from mentees, representing response rates of 54% and 21%, respectively. Whilst such response rates mean that any findings should not be generalised to the whole population of mentors and mentees, a qualitative outlook helps build a picture of what participants in the scheme experience and to inform the iterative improvement of the scheme when PALS is run in subsequent years. From the student responses, dominant themes emerged that mentees report contributed to the community of learning within the PALS: 'learning from lived experiences', 'insider knowledge', 'helping others' and 'developing academic and interpersonal skills'.

Learning from lived experiences

Mentees highlighted the valuable experience that the mentors had; this may be linked to the perceived value of discussing certain topics with those whom they saw as 'closer to themselves'. This is indicated in responses such as:

> Being able to speak to someone who has been through the same course.

> Being able to bounce questions off someone with insight and similar experiences to me.

These comments indicate that mentees found certain questions easier to ask mentors, potentially because they could see that the mentors are only a year or two ahead of their current position in terms of progress through their programme of study. Indeed, no matter how personable and understanding the teaching staff might be, students often struggle to see how their current place at university can lead to the position, experience, or qualification that their teacher might hold; students only a year or two ahead of them do not feel so far away to extrapolate from their 'now'. These shared experiences promote a sense of community, which can be seen developing from new friendships forming:

> I enjoyed the scheme and [it] also helped me meet a new friend at university!

This is particularly positive, indicating that some students found the environment was conducive to meeting new people and developing relationships that were likely to last beyond the PALS. Indeed, sometimes the shared interests between mentees and mentors established friendships.

Insider knowledge

A second theme emerged where mentees commented on the 'understanding' of the mentors and reported gaining 'insider' knowledge from their mentors. Since the mentor had been through the FY (with a high level of success because of the eligibility criteria), they were well-

placed to provide the student perspective on a particular assignment or assessment the mentee was due to complete during the academic year. Representative quotes from mentees include:

> Giving a better understanding towards the conference project task.
>
> They had a lot of experience and could tell me what was best to avoid and what module leaders are expecting from my work.

This suggests that the mentors gave insights into the 'hidden' or assumed understanding in some pieces of work, or that hearing similar or repeated advice in this environment was useful to them. The mentor is again well-placed to bridge the gap between the mentee's understanding and the module leader's expectation of a particular piece of work. Another positive indicator was the informal and accepting nature of the meeting environment some mentors had developed, saying:

> You can ask any reasonable question.

In both cases, seeking the 'insider' knowledge of an assignment or asking 'reasonable' questions may be perceived by mentees to be less accessible from the teaching staff.

Helping others

From the mentor's perspective, many comments surrounding sharing one's experiences were expressed, such as:

> Skills gained and being able to pass on tips I've learned over the past couple years.
>
> Just being able to share my tips and sort of guide people in the right direction.

In many ways, mentors developed an identity as role models for their mentees. Many enjoyed the chance to articulate their experiences to mentees, thus helping mentees to (hopefully) make better decisions:

> Getting to express my university journey to others who are in a similar position to me.

Having mentors who have shared some of the same experiences, emotions, and possibly overcome the same challenges as the mentees, lends authenticity and credibility in the eyes of mentees (something that teaching staff are not always in a position to achieve) and is one of the core aims of recruiting mentors from the FY alumni.

Developing academic and interpersonal skills

Both mentees and mentors reported developing academic and interpersonal skills through taking part in the PALS. 16 mentees responded to the question "Taking part in PALS has helped me develop skills in…" in the evaluation questionnaire (see Figure 1). Whilst three students reported that the scheme did not help them develop any skills, the remaining 13 students all reported that they had developed various skills as part of the scheme. The most reported skill was 'Finding and using sources of information', followed by 'Communication with others', 'Time management' and 'Organisation and Independent Learning'.

Seven mentors responded to the question, "Which skills/attributes do you think have developed as a result of your participation in PALS?" (see Figure 2), with the top responses being

'Explaining ideas', 'Questioning techniques', and 'Awareness of diverse learning preferences'. Furthermore, a theme that some mentors reflected on was developing skills to manage and engage with others in a group setting, in particular in taking responsibility as a leader. The following statements highlight some awareness of the skills needed to be a successful mentor:

> Being able to offer new students reassurance and helping them build their confidence.
>
> Trying to engage with other students on their studying required careful consideration of how to ask questions and make criticism constructive which is always useful in a managing role or just a group setting.
>
> Being responsible for arranging something but also following through with other activities afterwards like reflection."

Furthermore, mentors found that reviewing skills with others helped their studies:

> Having to explain good time management, revision skills etc with mentees reinforced how often I should be implementing these in my studies.

Importantly, academic skills are problematic to teach theoretically. They need to be practised to be understood and developed; acting as a mentor presented such opportunities.

Encouragingly, all respondents would recommend to their friends to become a PALS mentor, even when reflecting on the challenges they faced. Student perspectives offered suggestions on how to develop the PALS for subsequent years. A recurring theme from the mentors surrounded attendance and engagement as the main problem they faced, voiced via sentiments such as:

> I'm not really sure how one could encourage the students to actually engage in the program but that seemed to be the problem.

For mentors there were several reasons for attending sessions: they had volunteered for the position; they were very successful on the FY programme; they were in a position where the meeting would not go ahead if they were not there; and, of course, they were being paid! Mentees on the other hand were expected to go, but since there were no summative marks associated with participation, their buy-in to the PALS varied significantly. However, for some mentees, underdeveloped time-keeping skills were their main barrier to participating, which does imply that if they had remembered where to go and when, they may have attended and gained something from the meetings. An immediate improvement to be made for subsequent years is to timetable the meetings as a response to this challenge. These sessions would then appear on mentor and mentee university timetables making attendance more likely, particularly for those who fall into this group with underdeveloped time-management skills.

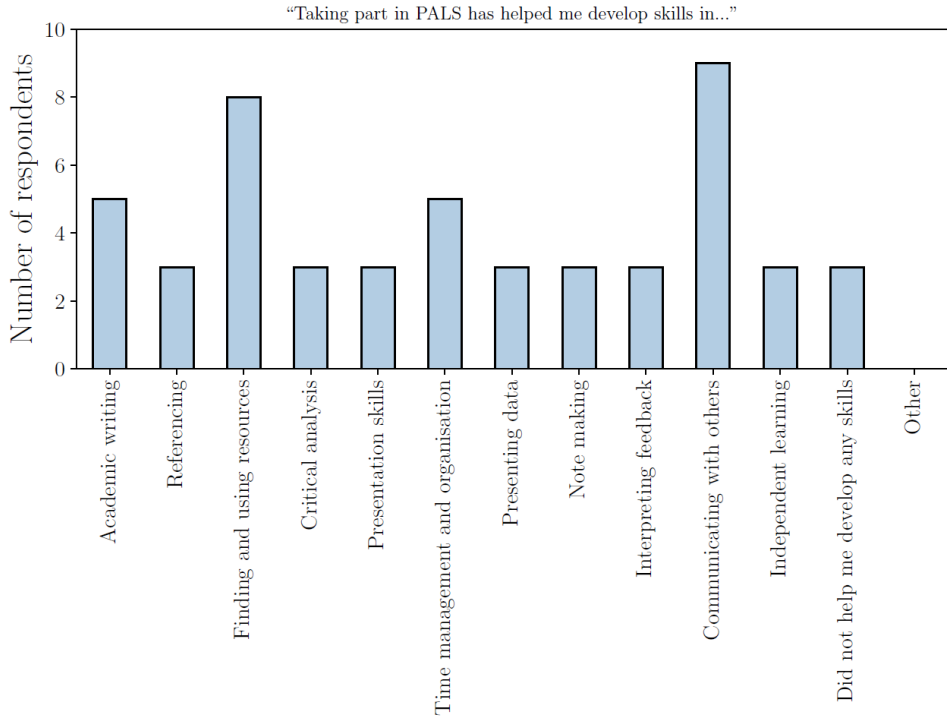

Figure 1. 20 mentees responded to the question inviting them to share which skills they felt were developed as part of their participation in the Peer Assisted Learning Scheme.

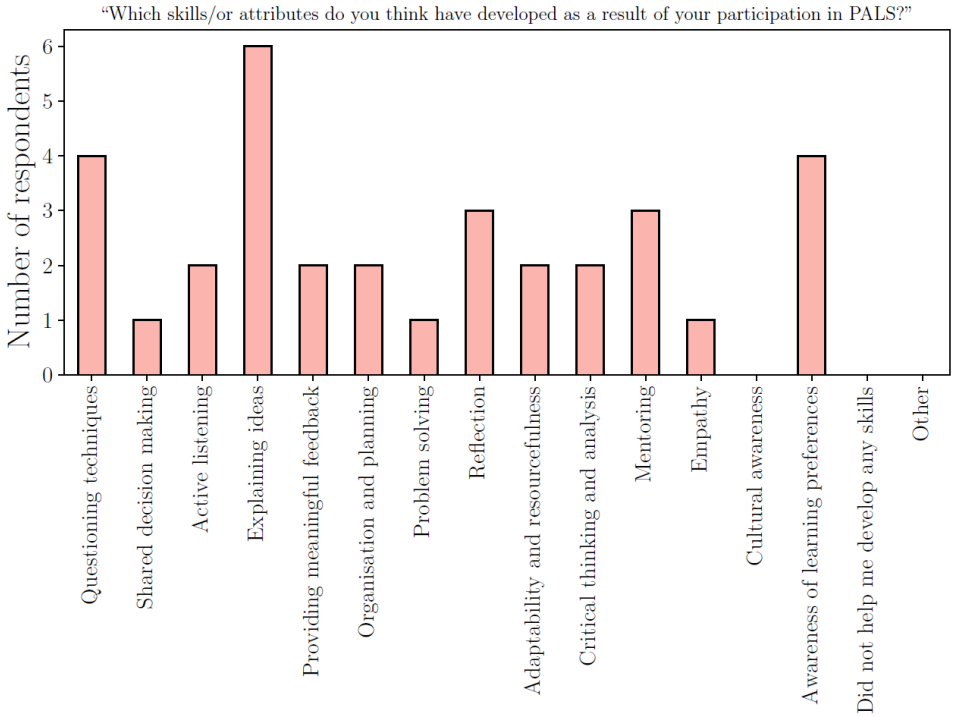

Figure 2. 7 mentors responded to the question inviting them to share which skills they felt were developed as part of their participation in the Peer Assisted Learning Scheme.

Group Project Creating a Business Case for an Engineering Idea

Evidence of developed group-working skills is highly desirable for the workplace and is also a requirement in accredited engineering degree programmes. Additionally, there is an assumption that group projects will enhance social interactions and help to develop the community of learning through peer-to-peer support. For these reasons, the inclusion of group projects in the FY programme is very important and students carry out two different group-based projects during the academic year of their EP&S FY programme. Here we outline one of these projects and share our initial reflections on its structure, operation, key observations so far, and future improvements. As this initiative continues to mature, quantitative and qualitative data will be collected and analysed to evaluate its effectiveness in enhancing the student community of learning.

Structure and Operation

During semester two of the academic year, students were placed by the module leader into small groups, typically four to seven members. Where possible, students were placed in groups with students that they had not worked with during the previous (semester one) group project. Groups were tasked with preparing a written business case and group oral presentation (a pitch) for an engineering, physical sciences, or communications-based idea. This was a summative piece of coursework as part of a compulsory module. Student group-working skills were expanded in semester two from previous learning in semester one via a package of academic support including:

- Staff-facilitated workshops as part of the timetable
- Microsoft Team channels set up for each group
- Liaison with the University's Student Enterprise team and the Entrepreneur-in-Residence who attended timetabled sessions
- Links to academic mentors from across the Faculty

An additional aspect of the project was that all student groups were automatically entered into the Engineers in Business Competition (see, eibc.org.uk). This competition included prize funds of £3000 with £1500 shared amongst the winning team members, £1000 shared amongst the second-placed team members, and £500 shared amongst the third-placed team members, as well as opportunities for teams to be mentored by Sainsbury's Management Fellows and enter the national competition. Inclusion of this competition in the compulsory coursework means that the Student Enterprise and Business Development opportunities (that are often extra-curricular options for students) were available for all our FY students without incurring extra pressures on their time or relying on the 'opt-in' approach which they often do not make use of. This also added a different dimension and extra motivation to the group project for many students, either because of the extra opportunities and/or the financial incentive and prestige.

Key observations

Whilst group work presents the usual frustrations for students and staff, it is impressive what some groups produce in a relatively short time. From the initial identification of a problem to focus on, to the inception of an idea to address the problem, researching financial, ethical and technological feasibility, refinement, and presenting a professional pitch to a panel of academics, entrepreneurs, and peers, who will challenge aspects of the pitch's claims, students must work together to be successful. Overwhelmingly, we have found groups have been able to engage successfully in this initiative, i.e., produce a suitable pitch of an engineering business idea.

Challenges and incremental improvements

Perhaps the most significant challenge, not dissimilar to that identified in the PALS, is getting the students to 'buy-in' to the positive learning opportunities this initiative affords them. Indeed, in Staff-Student Liaison Committees we often hear feedback such as, "We don't get why we have to do this." Or "This doesn't involve physics." We find there is a large inertia here, and the value of the initiative is often not fully appreciated until a later stage of study. Perhaps this comes down to a narrower mindset, such as a dualist encapsulation of knowledge that scientists, engineers and mathematicians typically exhibit early in their university education (Felder and Brent, 2016). Regardless, understanding the lack of buy-in from students in the FY cohort presents a key area for further research.

The second major challenge we have observed so far is that some groups struggle to move from the *idea-generating phase* to the *selection-and-refinement-of-an-idea phase* of the project. Rather, they have a tendency to select 'global problems' which, whilst admirable, can become demoralising for the group when all they can see are the problems to overcome to make it a 'viable business'. For example, 'commercialising space', 'new energy technologies' or 'global sustainability' resonate with many progressive ideals and issues students are passionate to explore, but they often struggle to break these ideas into suitable and manageable steps to explore more deeply and articulate what it is their business case is proposing to solve (or offer), and how it is going to be achieved. This tendency may be explained by another observation of students when selecting an idea for the project. Often, students try to formulate an entirely 'original' idea for the business case, expressing that many of their other ideas have 'already been done' or 'already exist'. This may lead to some adopting these large-scale global problems to tackle, since, by definition, these problems continue to exist in some form or another. In both cases, significant support, usually in the form of Socratic questioning at the group level, helps to move students between these phases and allows them to choose a manageable idea to refine and develop into a business case. Once they have navigated this stage, we found that the groups tend to be self-sufficient in developing their projects into a suitable pitch. In terms of immediate improvements, we have sought to enhance the idea-generating phase through practical examples via consideration of local problems or problems that affect the students' daily lives. Additionally, timetabled mentoring discussions with advisors from the Student Enterprise team at an early stage of the project, along with key prompt questions, and an interim report checklist have been incorporated.

There remain several key questions to be answered to enhance these interventions and improve the opportunities for integrated academic skill development and the communities of learning they may create. The difficulty we have observed in 'selling' these opportunities to students indicate a low level of 'buy-in' by the students. Whilst there are always examples of those who are happy to try new things or recognise the learning opportunities afforded to them through engaging with these interventions, they are in the minority. The balance between the flexibility of idea generation, research interests, and topics for discussion maximise the breadth of ownership of utilising their mentors (in the PALS) or ideas to explore (in the business case). However, with low levels of buy-in, this flexibility is undervalued by students. Indeed, this issue has been observed in other initiatives that students do not immediately see the 'value' of (Baker and Spencely, 2020, 2023). On the other hand, a prescriptive and heavily scaffolded approach does not leave as much room for students to *own* their work.

Concluding remarks

As our title indicates, contrary to the popular image invoked on hearing 'scientists', 'engineers' or 'mathematicians', these students do not just sit and "do" equations, and certainly not always by themselves. Social aspects of learning are an important part of the university experience as well as a basis for constructing a higher-order and developed understanding of course content. We implemented initiatives that foster peer-to-peer learning and create 'communities of learning' and embedded them into compulsory academic modules, ensuring all students are exposed to them as well as implicitly highlighting their relevance by being part of the perceived more 'important' (traditional academic) modules. Two examples were described, a 'Peer Assisted Learning Scheme' and a 'Business case in Engineering group project'. Student voice captured as part of an evaluation of the former scheme suggests that our students generally agree that these social aspects of learning (creating communities of learning) are valuable for the academic skills development and learning development opportunities they provide. Perhaps most importantly, these embedded initiatives engaged our students more readily than existing 'opt-in' initiatives which often only the most conscientious (or staff-referred) students opt into.

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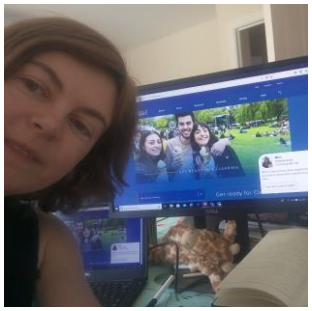

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