



**CENTRES FOR
EXCELLENCE IN MATHS**



**“How can blended learning be used to engage students in
the learning experience?”**

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OUR PARTNERS



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FUNDED BY



Department
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Working in partnership with the Education and Training Foundation to deliver this programme.

Acknowledgements

Thanks go to Cath Gladding for the online research training, Joss Kang for support in the online sessions, and the University of Nottingham for the use of some of their trial materials

About CfEM

Centres for Excellence in Maths (CfEM) is a five-year national improvement programme aimed at delivering sustained improvements in maths outcomes for 16–19-year-olds, up to Level 2, in post-16 settings.

Funded by the Department for Education and delivered by the Education and Training Foundation, the programme is exploring what works for teachers and students, embedding related CPD and good practice, and building networks of maths professionals in colleges.

Summary

Blended learning has been seen as a potential solution to FE education issues around flexible learning, different learning styles and student-centred learning. Progress has however been very slow in many colleges. The recent Covid pandemic has pushed educational institutions to develop fully online and blended approaches in a very short period of time with knock-on consequences for students and teachers.

Our action research group had reflected on the limited education we were able to provide during the first lock-down (March to June 2020) and considered the implications of our new timetable in September which mixed face-to-face and online lessons as well as the likelihood of further full lockdowns. A major concern was how to engage GCSE Maths resit students, who have a whole series of barriers to learning already, with their learning through a blended approach. We wanted to look at how you replaced or improved on key classroom practices such as group activities, regular feedback for students that informed further learning and teachers' ability to monitor and maintain student engagement in the lesson.

Four staff worked with 5 classes of Grade 3 students to try out a range of online platforms before deciding to focus on Desmos. They explored how to get the best learning outcomes and engagement from its features through three activities on ratio, proportion and simultaneous equations, linked to our Scheme of Work.

Students as a whole cohort were given a questionnaire twice about their experience of online learning. Teacher reflections and student interviews were used to review the effectiveness of the activities.

It was found that students had quite different experiences with online learning. On the positive side some students enjoyed greater independence with their learning, liked not having to come into college or the ability for more private feedback with the teacher. Others however, struggled with having suitable technology, with up to a half completing lessons on their smartphones, as well as having connection issues. The lack of face-to-face teacher support and interaction with peers was also raised by many.

Desmos itself was seen to have highly effective tools for monitoring, engaging and giving useful feedback to students and teachers. As such training for staff on lesson delivery through Desmos, activity planning and the ability to adapt the software to suit are key to this effectiveness.

As we return to more face to face teaching, we expect to retain the positive learning experiences that Desmos has given us by adapting its use within class lessons.

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Background

Our college and cohort

“Working within a safe, welcoming and stimulating environment, which embraces diversity and promotes respect, we help students fulfil their academic potential and become thinking, questioning and caring members of society.”

Leyton Sixth Form College has about 2000 students, mostly aged 16-19 and studying full time at level 3. Around 60% of students are doing A-levels and 40% are on vocational programmes such as BTEC. We also offer BTEC and ESOL courses at Level 1 and 2 to enable students to access further learning through progression at the college. Around 600 plus students go on to university each year from both A Level and Vocational courses. Nearly a hundred students gained places at Russell Group universities last year.

“Waltham Forest is currently ranked 82nd most deprived borough nationally according to the 2019 Index of Multiple Deprivation (an improvement from 35th in the 2015 edition, and 15th most deprived in the 2010 edition).”

<https://www.walthamforest.gov.uk/content/statistics-about-borough>

We have been a member of the Centres for Excellence in Mathematics (CfEM) since October 2018. We participated in the CfEM research project National trials for Mastery with the University of Nottingham in 2019-2020.

Our learners and our goals for GCSE Maths

Since it became mandatory for students who had not achieved a “pass” (C or 4) at GCSE to re-sit, the GCSE resit programme has grown from around 200 students to around 600 students. We offer GCSE Maths to all students who have not yet achieved a grade 4. We split this cohort into two courses, one for students who have a grade 3 and are working towards a grade 4, and one for students who have less than grade 3 with the goal of achieving a grade 3 and progressing to the next level alongside the other courses they are doing the following year. The value added on these courses is excellent, and overall students on the 3-4 level do better than the national benchmark for success in GCSE resit Maths, but we are ambitious for more of our students to pass GCSE Maths before they leave college.

Here’s how the students on different courses do compared to the cohort doing GCSE resit with the exam board (Pearson Edexcel). It’s important to bear in mind that many FE colleges prefer to offer Functional Skills qualifications to students who have less than grade 3 at GCSE Maths.

Students achieving grade 4+ in GCSE Maths	2018	2019	2020
All FE students (Pearson)	19.40%	18.20%	unavailable
All LSC students	19.85%	16.90%	25.40%
3-4 course	30.42%	29.80%	42.55%
0-3 course (NB target grade is 3 not 4)	1.99%	1.52%	1.61%

Research Aim

We carried our research to investigate different blended learning platforms and approaches to see which can be best used to engage GCSE resit students in their learning. Here, by “blended learning” we mean learning where a significant proportion of the teaching and learning is delivered using technology, which may be site based or delivered remotely. Our motivation for this investigation stemmed from the current pandemic. During the first lockdown in Spring 2020, we realised that a large proportion of our lessons would have to be delivered remotely and that we were inexperienced in delivering content in this way. We also realised that vast numbers of our students had problems accessing technology and that many had access only to basic technology eg mobile phones, rather than to laptops or tablets.

We reviewed literature based on synchronous and asynchronous blended learning and researched several different platforms such as Jamboard; Dr Frost Maths whiteboards; whiteboard.fi; OneNote for class notebooks; Zoom whiteboard/annotation and chat; Desmos; MyMaths; and Microsoft Teams.

Literature Review

There is very little research on blended learning within FE and even less that is relevant to GCSE resit maths, at the moment. Most of it has been done at HE level and often where remote learning is a necessary part of the course. However, the Covid pandemic has had a dramatic effect on how colleges teach and there are plenty of studies that have taken place recently that should soon add considerably to our understanding.

Blended learning is an educational term that has been around for some time but has been used to describe such a whole range of activities and situations that it is hard for teachers to have a shared understanding of what it means or what it looks like. Most of the research on blended learning has been done at HE level and often where remote learning is a necessary part of the course.

JISC's "Developing blended learning approaches" guidance, gives a very practical definition as

"A combination of face-to-face learning and dynamic digital activities and content that facilitate anytime/anyplace learning".

They also differentiate between hybrid learning with technology used to support face-to-face learning, remote learning and independent learning combined as opposed to just online learning.

Poon (2013) looks at the motivation behind blended learning for a definition and suggests that it could see either as,

"Varying learning methodology, understand more about what motivates learners, what support they need and how these supportive interventions can take place in practice".

or

"A fundamental redesign of the instructional model with a shift from lecture-centred to student centred instruction where students become active and interactive learners".

There are bold claims made for the impact of a blended learning approach and Poon states that there is an expectation of "a significant relationship between blended learning, student learning experiences and ultimate achievement.' Lopez-Perez & Rodriguez (2011) suggest there is considerable evidence that blended learning can positively impact student achievement, 'can foster a decrease in student attrition and facilitate an increase in the passing rate for student examinations.'

Other studies suggest a different outcome with the investigation by O'Toole & Absalon (2003) revealing that the provision of materials in electronic format has limited benefit and can even have an adverse effect on student performance due to misplaced confidence in the media through which it is delivered.

As such Poon says there needs to be a consideration of learners' needs, taking into account their reasons of motivation versus their ability to cope with online learning.

She continues that the advantages of blended learning are flexibility of learning, reinforcing student autonomy, reflection and powers of research. This can also include prompt feedback, but this is dependent on how frequently students engage with the platform. On the

flip side the challenges are reported as unrealistic expectations, isolation, students believing fewer classes' means less work, inadequate time management skills and problems accepting responsibility. Issues of poor internet connection are also highlighted.

It is also unclear how we define success within this new approach. Stacey & Gerbic (2008) state that it is "practice which promotes achievement of high-quality learning outcomes and positive student learning experiences with high teacher satisfaction and a reasonable workload.'

So, what are some of the key features of blended learning that could be relevant for our GCSE resit students? Wang et al (2018) found that an interactive approach, coupled with other teaching forms and delivered through mobile technologies provided more flexibility for both teaching and learning of computer programming, greatly improving students' academic results in the course. However, a study by Clayton et al (2018) comparing students' preferences for traditional versus non-traditional learning environments found that students preferred traditional and justified their choices by citing them as engaging and interactive. Interestingly a study by Chen et al (2018) found that learner interaction with a corrective feedback tool was positively correlated to performance. Learners who got the correct answer on the first try and therefore bypassed the feedback tool performed worse, with a 25% variance in cumulative grades. The authors concluded that the added engagement provided by immediate corrective feedback reflects a productive study strategy and can significantly predict higher overall performance.

This indicates that learning in a more flexible way will be welcomed by students but that it will have to be engaging and allow plenty of interaction with peers or the teacher. Also, online activities that give quick feedback to students they can actively use to develop their understanding could improve their progress.

There are already lots of Maths specific online tools that are suitable for GCSE and a summary of recent research by Rycroft-Smith et al (2020) highlights the following key points. Firstly, there is a variety of methods to teach and learn Maths remotely and the use of synchronous and asynchronous methods is likely to be complementary. Secondly, remote maths learning is an opportunity to try new pedagogies; it increases flexibility and connections for isolated students although it can be more difficult for teachers to notice student anxiety or disengagement when working remotely, and it may increase workload and stress for parents or carers. Thirdly, selection of resources for remote learning is particularly key: online activities and apps for maths learning exist, but many are of poor quality, or fall only into the instructive category which they compared unfavourably to constructivist and objectivist methods. Finally, representing mathematics in dynamic and visually rich ways and encouraging peer interaction supports remote maths learning.

Currently our students' most common use of online Maths tools is Mathswatch for homework, which gives immediate correct/incorrect feedback but does not support students particularly well if they do get it wrong. Given the key points from the research above, we need to look beyond this type of platform to find something that gives students feedback but in a way that engages them with the learning process.

So, what different types of digital maths teaching tools are available and how effective can they be? Hoyles (2018) categorised tool-use into six areas.

- Dynamic and graphical tools – e.g., Geogebra

- Tools that outsource processing power – e.g., Graphics Calculator
- Tools that offer new representational infrastructures for mathematics
e.g., Online manipulatives/representations
- Tools that help to bridge the gap between school mathematics and the students' world – eg. Simulations, microworlds
- Tools that exploit high-bandwidth connectivity to support mathematics learning.
- Tools that offer intelligent support for the teacher when their students engage in exploratory learning with digital technologies.

They argued that the content of digital maths teaching and the format in which it is presented are inextricably linked when it comes to measuring their impact on learning. The mere presence of digital technology or even the ready access to data makes little difference to student learning outcomes. Outcomes depend on how all these resources are used separately or in combination.

We were particularly interested in the use of dynamic and graphical tools, about which the author stated.

“Using these tools, learners can explore mathematical objects from different but interlinked perspectives, where the relationships that are key for mathematical understanding are highlighted, made more tangible and manipulable”.

“Care needs to be taken to guide students in ways that interweave the pragmatic and the epistemic; so, they first notice the impact of the changes made, and second have some appreciation as to why the changes are significant mathematically”.

Linked to this, a study of a multimedia approach to learning algebra by Smith et al (2015) highlighted the previous research on cognitive load theory which asserts that learning is impaired when working memory is overloaded by attempting to simultaneously process overly complex information through the visual and auditory channels. Multimedia content can be designed to optimize learning but to do so, it must factor in the limitations on working memory. Importantly, “people understand a multimedia explanation better when they are able to control the order and pace of presentation”. Students in the survey highlighted the following positive areas.

- The ability to control the pace of instruction
- Increased opportunities for one-to-one tutoring in the classroom by the teacher
- The lack of distraction in the blended learning environment
- The accessibility of the embedded multimedia lessons outside the classroom

All the online tools we are currently exploring as part of the project tick some of the boxes the research shows are important however Desmos which we have been using in a limited way for a while does seem to have the facilities to address most of the requirements. Clearly how we use it with students, the choice and development of content and the focus on feedback to develop understanding are all key to engaging students in a blended learning environment.

Methods

Our research took place over 3 cycles. In the first, we identified the platforms we wanted to investigate; in the second, we briefly trialled them to help us to decide which ones to focus on, and in the third, we focused our attention on using one of them: Desmos. We chose 3 Desmos activities: on ratio - a paint mixing activity produced by Desmos; a proportional reasoning activity adapted from a Ben Sparks Standards Unit N6 lesson; and a graphical solutions to simultaneous equations lesson produced by adapting an activity produced by a teacher, Michael Kegel. These were all tied into our scheme of work.

The paint activity was chosen because it was thought to be easily accessible to weaker students but also had slides designed to stretch more able students. It had been used previously by one of us and its “show, don’t tell” approach in response to students’ answers had proven to be an effective means of feedback and was appreciated as such.

The proportion activity had also been taught previously, without technology in a face-to-face setting, and was adapted to include using double number lines for proportional reasoning, which is an important aspect of the mastery approach that we are adopting as a department. As a team, we had a wide experience of using standards unit activities and knew the proportion activity but weren’t able to use it in person during the ongoing pandemic.

The simultaneous equation activity was chosen because it was generally considered to be a topic which students found difficult and because Desmos was thought to be particularly useful in engaging students with dynamic graphical representations. The original activity was designed to be used with students of electrical engineering, so needed to be amended considerably to be accessible for our students who didn’t have this background.

Each of the activities was adapted in order to get feedback from our students on their learning experiences. We introduced for each activity a final slide in which students were asked how they felt about their learning and in particular about their confidence levels.

Our initial approach in investigating platforms was mostly qualitative rather than quantitative. When trialling them, we focused on our general thoughts about what we felt went well and what didn’t go so well.

For the purposes of our investigation, our students had all achieved a prior grade 3 and were in our Foundation Plus classes. Some of the students have sat GCSE multiple times.

Desmos was chosen for several reasons. It proved to be reliable, accessible and easy to use (for both teachers and students). Moreover, the speed at which learning could take place, its flexibility, the ease with which activities could be adapted, and the fact that it could be used both synchronously and asynchronously, all proved to be important features. It also allowed good teacher control of lesson pacing and was easy to use remotely from home on a wide range of devices - though card sort activities were problematic on relatively small mobile phone screens.

It proved to be difficult to find relevant academic literature on blended learning as there seemed to have been a limited amount of recent research on blended learning in institutions similar to ours. The available literature was mostly from either higher education institutions

or institutions largely engaged in correspondence courses; and there wasn't very much literature available on synchronous blended learning.

Students were informed that they were taking part in an action research project although most of their experience of learning during the pandemic must have felt like that. All data collected from students has been anonymised in this report.

Data collection methods were included in the actual Desmos activities in the form of a standard final feedback slide which we included in each of the activities. We also used teacher reflection (we met as a group on a fortnightly basis), teacher interviews, student interviews and 2 student questionnaires: one consisted of an online questionnaire and a second follow up paper questionnaire to further explore some of the issues highlighted by students in the online one.

Number of Participants

Teachers	4
Classes	5
Total Number of students	91

Class size varies from 13 to 23 students, this depended on other timetabling constraints. Students were on a mixture of Level 2 and Level 3 courses (both Year 12 and Year 13), but all had previously obtained a grade 3 at GCSE Maths.

Sixteen students were interviewed in more depth (in pairs), having reviewed the work done on Desmos by the students.

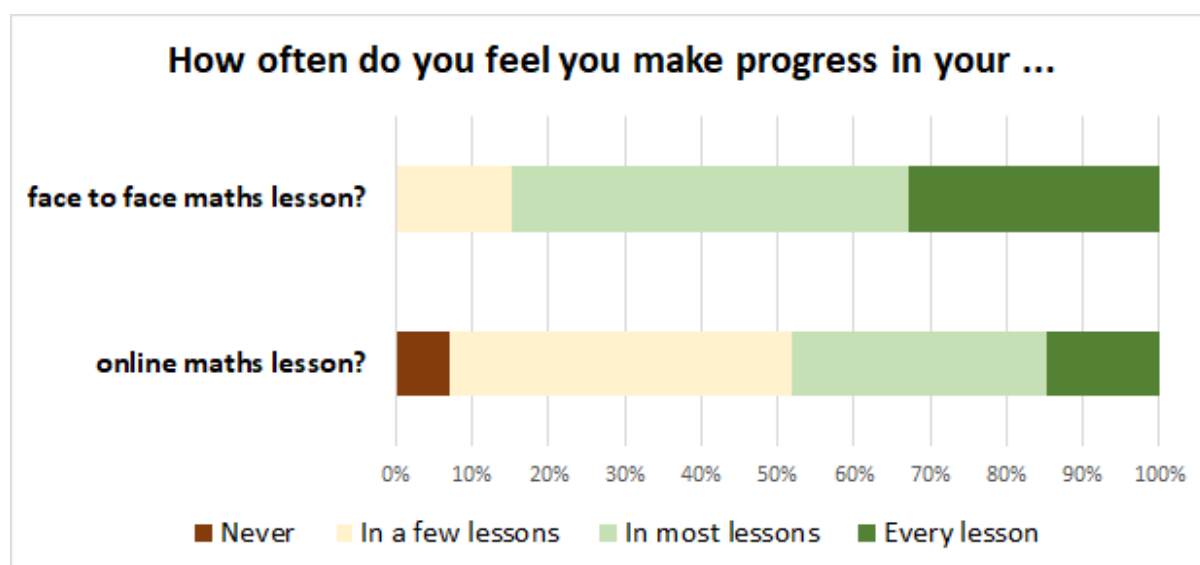
Results and Discussion

Student Initial Questionnaire on Blended Learning Experience

This questionnaire was given to all GCSE Mathematics students, whether they were part of the action research study or not, when the college resumed face to face teaching in March 2021 after the COVID second wave lockdown. There were 170 respondents. Responses highlighted issues which as the research team we wanted to investigate further using the classes selected for the blended learning project.

The questionnaire covered online lesson structure, the student view on best/worst aspects of online lessons, their progress online versus face-to-face lessons, seeking help when stuck, improvements that could be made to online lessons and their access to online learning.

It is clear that many of the whole cohort had found online remote learning far more challenging than face to face learning. For face to face learning some 85% of students felt they made progress in most or every lesson. This compares with only 49% of students in an online lesson. Just as significantly there were 7% of students who felt they never made progress online, there were none in this category for face-to-face lessons.

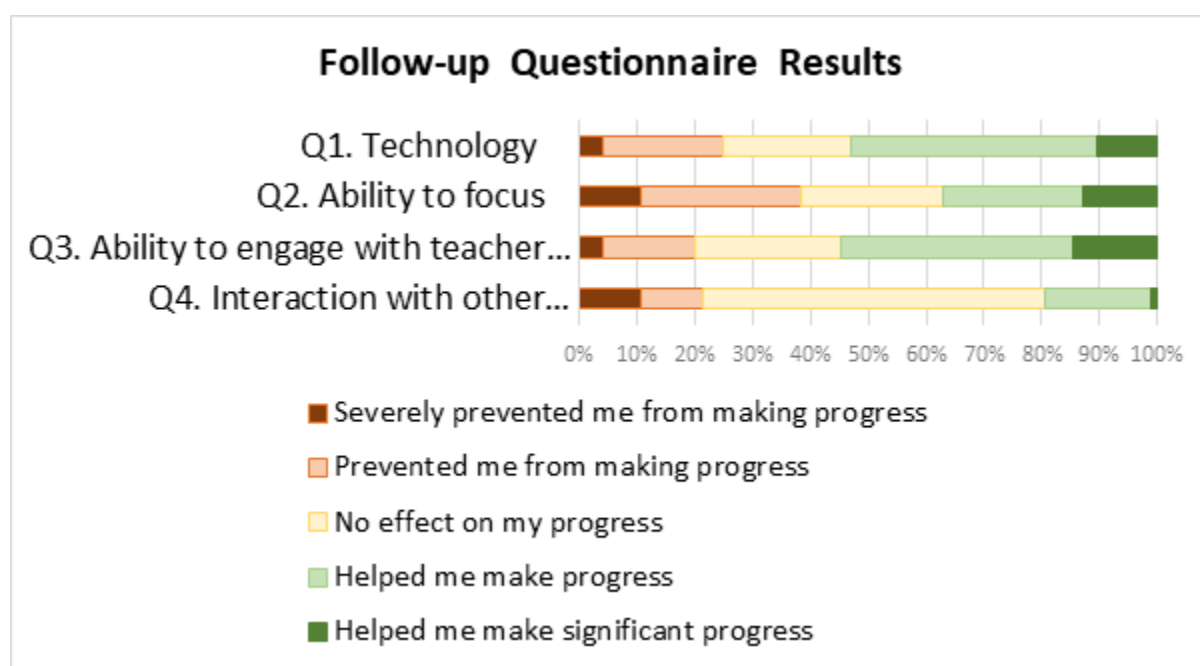


In response to the question “What are the best things about an online lesson?” the most popular answer was clear teacher instruction (18%), followed by being relaxed and comfortable (15%), don’t know (13%) and no travelling/ safety (11%). (The questionnaire was taken in December after a term working 50% online 50% face-to-face.)

In response to the question “What are the worst things about an online lesson?” the most popular answer was connection issues (19%), don’t know (16%) and boring or tiring (12%).

From these responses and our experience of our students having difficulty accessing lessons we designed a follow-up questionnaire using issues highlighted by these answers to get a more detailed understanding of the difficulties the students in our AR project faced engaging with synchronous online lessons.

Student Follow-up Questionnaire on Blended Learning



More than 50% of the students told us that technology helped them make progress, with 22% of them stating that it prevented them making progress.

Responses from students included how easy/not easy it was to access lessons and varied from

- *"It helped a lot to improve; I had no problem whatsoever"*
- *"Mine was fine at times but it did help me progress more as I was aware on what I had to do."*

to

- *"Sometimes I have to share a laptop with my sister & it was a bit hard for me to work."*
- *"Wifi was a big issue at home so joining online lessons was a struggle."*

Around a third of students told us that their ability to focus was improved by working remotely. However almost 40% of them found working remotely really hindered their ability to focus.

Hindrances often related to students' home environment: -

- *"Sometimes I get really distracted at home because I have 4 sisters and from that sometimes I can't understand what we are doing in lesson."*
- *"It's hard to work from home as there are many distractions and just too noisy to concentrate."*
- *"Lack of space, too loud, this has affected me in a big way."*

Those who told us that their ability focus was improved often quoted issues like:

- *“Easier in own environment more comfortable.”*
- *“Focused at home since I was comfy and had space to study.”*
- *“Less talking needs to be done by the teachers so we can go straight to the task.”*

Some 55% of students stated that their ability to engage with the teacher using Desmos/Zoom helped them make progress. Around 20% found this process a hindrance.

Positive comments included ones such as the ones below, which were numerous, many showing the appreciation of the ease with which they could interact and build relationships with their teachers.

- *“The Zoom private chat was really useful when need to talk to teachers.”*
- *“Private Zoom chat was very useful, without interrupting the lesson I could ask questions.”*
- *“... has been the best teacher in lockdown and provided resources and actually listened to what I said and valued me which I appreciate.”*
- *“My maths teacher gave us many resources I liked Desmos, my maths during lessons & I would private chat my teacher & ask for help, I would get the help I needed.”*
- *“Teachers were easy to reach and interact with.”*
- *“I ask many questions on Zoom's private chat because only your teacher can see it.”*

For those finding the process a hindrance the comments below were typical.

- *“It was hard to ask questions because of Wi-Fi issues and audio would cut out.”*
- *“I would lose focus or motivation to stay engaged with what the teacher is saying.”*

Around 60% of students felt that the technology didn't affect their interaction with other students and a further 20% stated that it actually improved it. Staff used breakout rooms as part of their lessons to help students interact, as well as the facilities on Desmos. Also, whilst not specifically mentioned in the student answers on the survey teaching staff know that many students also supplemented the classroom channels with technology such as WhatsApp to contact other students, particularly if their wi-fi was slow. *“Can you let onto the Zoom call”* was heard regularly, as were things like *“’s electric has run out, s/he’ll be back on in a while.”*

Teacher Reflections on Desmos

The Desmos activities that had automated feedback for students worked best - where students could see if their answers were correct, rather than wait for their teacher to give them feedback individually. This requires knowledge of the computation layer on Desmos to implement - something we only learned part way through the project. It is particularly relevant if you want to use activities teachers have made (e.g. Developing Proportional Reasoning) - rather than ones like Paint, which Desmos had produced. Student feedback also indicated that they preferred the activities with instant feedback allowing them to adjust their method if needed.

Teachers found the pacing facility on Desmos useful to ensure that students wrote full explanations when asked for rather than racing on to the next part of the lesson. It was also extremely useful to be able to cut and paste student answers using the snapshot function within Desmos for comparison purposes and using the pause function to promote class discussion when students were having difficulties with the work.

The messaging facility on Desmos was also useful to give individual students responses and prompts without interrupting the whole class.

Teachers found classes in general to be interested and keen to get involved with the work on Desmos. Sometimes more time would have been useful, interacting with students virtually was quite time consuming. However, when the time ran out teachers found that some students were willing to continue with the work in their own time to increase their understanding of a topic - leaving the activity open after the lesson had finished.

We added a summary slide to all the activities asking students to give feedback about how they felt about the topic now. They consisted of "I understand ...", "I understand it a bit but I still find it difficult", "I still don't understand it." The feedback gained here, together with free written feedback in a comments box was extremely helpful when planning future lessons and considering what intervention students might need next. Many students in the comment boxes stated that they felt they needed more practice and one of the key things to come out of using Desmos lessons with the students was the number of them who through the activities realised that practice was as important as the subject knowledge - something that GCSE re-sit students frequently do not appreciate.

As a teacher on the remote end of Desmos one of the key advantages we found compared with most of the other software at the moment is that you can see your students progressing with the activity. This means that you quickly become aware of students who have become distracted or disengaged with the activity and can then interact with them to find out why.

Sometimes student comprehension was an issue if they were reading the slide instructions - with a few not certain what they were supposed to be doing. This was particularly the case with latter screens in a Desmos activity where the task was being extended to more challenging contexts and tasks. Once again various feedback and help functions, including Zoom chats, were used by teachers, but could be quite time consuming. For longer activities in future we would sub-divide them into two, to avoid too much time online in one go and allow a new introduction to be made to the more challenging work.

One difficulty that we had with Desmos was using card sorts on small screens - a number of students only had a mobile phone to access the net at the start of the lockdown and the screens just weren't big enough to allow them to access the activity. It was important to know the type of devices a student had to use. On being made aware of the issue, we organised the loan of appropriate devices to those students affected.

Desmos – Pedagogy

Here are some highlights from teachers reflections on using the Desmos activities with their classes

Ratio - Paint (written by Desmos team)

"Instant formative feedback from this task meant students were more resilient, having multiple attempts until the correct answer was found."

"I did far more individual interventions than I normally do with a Desmos task on the basis that [students' responses to] slide 3 showed clearly a lack of understanding about how to represent the problem. That intervention was eventually successful."

Proportion - Standards Unit (adapted by the AR team)

"Trying a range of proportion questions, spotting and commenting on mistakes, showing working on the DNL and inventing their own puzzles was too much for one session both in terms of time and ability to focus."

"Change so more of the slides gave instant feedback to the students."

Simultaneous Equations (adapted from an activity produced by another teacher)

"Many students continued to struggle with: (a) their understanding of $y=mx+c$ and in particular with the notion of gradient (b) being able to associate the points on a graph with solutions to the graph's equation."

"The activity needs significant revision. ... Re (b) above, it would be useful to include slides in which there is a *single* equation of a line and its graph where students are invited to say whether given point(s) are on the line and to say what further points are on the line."

Student Desmos Interviews

Following each Desmos lesson a small sample of students were chosen to be interviewed about their experiences. These were conducted in pairs with a consistent framework of questions used for each interview. All interviews were carried out by someone independent of the classroom teacher.

Somewhat encouragingly, 75% of students said (question 1) that they enjoyed the Desmos activities. Although a number of reasons were given, the biggest single factor highlighted here (in 25% of cases) was "variety" i.e., the fact that the activities themselves consisted of varied tasks. This was reinforced by the responses to question 9 relating to what students found positive in their Desmos lessons. (Also, in a later question, 56% said that they liked

the fact that in Desmos answers can be shared within a class and that they could in this way check their answers against those of others.)

Just under half (44%) of the students said (question 2) that the activities helped them to learn the topic in question with 6% saying they learnt something but needed more practice and 6% saying they found it helpful with topics that would otherwise be confusing; with the main features cited as facilitating their learning being good teacher feedback (referred to in 25% of cases) and the fact that their teacher can see their work (19%).

On the face of it, it might seem that the proportions here are quite small and it certainly would have been more encouraging had they been bigger. However, it should perhaps be borne in mind both that the topics that we chose were ones that many students tend to find rather difficult; and that the activities took place during a period where lessons were being delivered online – and we know that students generally prefer face-to-face rather than online teaching.

For these reasons, it would seem that none of these results should give us grounds to question the use of Desmos activities in, in particular, face-to-face classroom settings. Indeed, in relation to question 8, nearly 70% said that they understood the topic (of these just under 44% saying that they nevertheless needed more in class practice).

Question 4/5 was primarily concerned with the slides in Desmos in which explanations were required e.g. where a student has to say what is wrong with a given answer. This is a skill which we know a large majority of our students find difficult and this was reflected in their responses: almost 1/3 admitted to finding these questions difficult; 25% saying that they just didn't have the right words to express themselves; and just under 20% saying that they ended up responding to these questions by writing their own solutions to the question instead of identifying mistakes in the answers given.

On reflection, these responses should perhaps not be surprising. Why should the mere fact that these difficult questions appear in a Desmos activity of itself make the difference – particularly for students who in any event find it difficult to express themselves? However, it would perhaps be a mistake for us to respond by removing these questions from future Desmos activities.

Nevertheless, careful consideration will need to be given in the future to how these slides appear in future activities. One possibility might be to put in earlier slides in which mistakes to given answers are identified. Also, we should perhaps make sure that only one or at most 2 “spot the mistake” questions appears per slide in order to avoid overwhelming students who already find this skill difficult.

Conclusions and Recommendations

Blended learning using Desmos alongside platforms such as Zoom can successfully be used to engage students in the learning experience due to its facility to give students and teachers instant feedback about the learning taking place, that is developmental for the students.

However, if blended learning is to be successfully used in this way, it is vital that students are able to study in an appropriate environment and that they have access to the right technology. If the blended learning takes place in a classroom setting, this will mean that there needs to be enough computers/laptops/tablets for each student.

Further conclusions and recommendations

- Students enjoy and engage with Desmos
- Where students fail to engage this is often due to lack of technology or suitable working environment
- Technology is not necessarily an issue when teaching face-to-face
- Equitable access to technology is important
- There are significant hidden costs to delivering courses online. It is important to understand the financial implications if looking to deliver course via this route in future
- Continued use of Desmos in classroom lessons post lockdown would support learning but it's use must be carefully linked to the Scheme of Work
- More staff CPD on delivery lessons on Desmos is required
- Strongly recommended that at least one member of maths staff has the technical skills to use the computation layer to adapt lessons to their situation
- Keep an eye out for Desmos developments from the AMSP around CPD and Desmos team developing the Math 6-8 curriculum which is highly relevant for GCSE resit.

The college spent some £117,000 on ensuring students could access technology during the pandemic (roughly £60 per student), which was essential for any blended learning to take place during this period. This included:

- Creation of three PC rooms for onsite Zoom lessons whereby students with poor connection at home could book time on site
- Laptops issued to students after upgrading and refurbishing some with new batteries and SSDs
- Costs of cameras, headphones
- License costs of Zoom and other technologies such as VDI (remote Access)
- Roll out of government issued low quality Laptops

Also key for some students with no internet access at home was

- Issuing of various mobile data SIMs to students – donated from Vodafone

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Appendix

Desmos activities

[\[Copy of\] Paint • Activity Builder by Desmos](#)

[CFEM - Standards Unit N6 - Developing Proportional Reasoning \(UK\) • Activity Builder by Desmos](#)

[\[Copy of\] Simultaneous Equations • Activity Builder by Desmos](#)

Student Interview Questions

Student interview – Desmos Paint Activity – Blended Learning

- 1) Did you enjoy the Desmos activity?
- 2) Did the activity help you learn the topic?
- 3) On slide 2 you were able to try a paint combination and see if it matched and then try a new one if you needed to. Was this helpful?
- 4) Do you like writing “Explain your thinking”? Did it help your understanding? (slide 3)
- 5) Did you share this with the class? Do you read the other answers? Does this help you?
- 6) What methods did you use to solve the paint on the wall problems? (slide 4/5)
- 7) Do you like setting your own challenges? Did you attempt anybody else’s challenge? (slide 6)
- 8) Did you feel successful with the activity? Did you know if you had got things correct or not? (slide 7)

Student Interview – Desmos Proportion Activity – Blended Learning

- 1) Did you enjoy the Desmos activity?
- 2) Did the activity help you learn the topic?
- 3) On slide 2, how confident did you feel about your answers? Did you need to know if you got it correct?
- 4) How did you solve Slide 3, Confident? Important to have feedback?
- 5) Slide 4/ 5 - How do you find explanations? Did you show them to the class? Did you look at others? Is this useful?
- 6) Slide 6/7/8 – Did you use the diagrams and/ or the explanations. Does the DNL help your thinking/ Know if you are correct?
- 7) Slide 10 – Did you make up a question? Did you make it easy or hard, how did you know? Did you look at others? Did you attempt anyone else's questions?
- 8) Slide 11- How do feel about the topic
- 9) What is positive / negative about Desmos activities

Student Interview – Desmos Sim Eqns Activity – Blended Learning

- 1) Did you enjoy the Desmos activity?

- 2) Did the activity help you learn the topic?
- 3) On slide 2, Did you play around with the sliders? How did this help you? What did you find out?
- 4) Slide 3 – How did you solve this? Did you know if you were correct? How?
- 5) Slide 5 – Did you write an explanation? How do you find writing these, is it helpful? Did you look at other students' answers? Is that helpful?
- 6) Slide 7/8 – Did you know what to do? How confident were you that you were correct? Was slide 8 any different? Harder? Easier?
- 7) Slide 9 – Did you try slide 9? Did you find a solution? How do you know you were correct?
- 8) Slide 11/12 – How did you try to find a solution? How would you know if it was correct?
- 9) How do you feel about this topic now?
- 10) What is positive / negative about Desmos activities