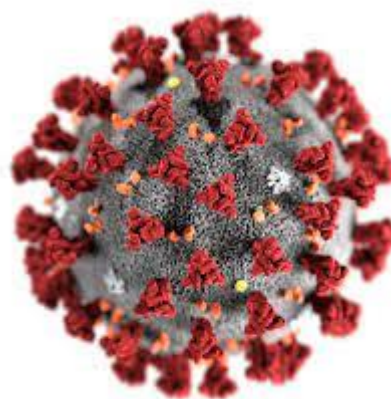




Can Mastery methods be applied online to the teaching of ratio?



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OUR PARTNERS



FUNDED BY



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

Acknowledgements

Thanks go to our wonderful students for being so willing to work with us on something new especially in such a difficult term. Their willingness to try something new and give us constructive feedback on the process has made this project and helped us all reflect on how we can teach online.

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

This action research took part during the recent covid pandemic focusing on the impacts of virtual learning. After having previously gained a lot of success using mastery methods within a classroom with maths' students we wanted to see if we could continue with this success outside of the classroom in a virtual world. We wanted to recognise the differences of moving traditional classroom situations online and see if we could inject the same positivity within our groups.

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Background

Introduction

Gateshead College was established in 1955 and currently delivers numerous vocational, academic and higher level courses across six sites campuses. Last year Gateshead College had 2524 students on education programmes for young people. Two thirds of these learners study at level 3, almost a quarter at level two and a small proportion at entry level and level 1. There were also 1389 adult learners on programme, 1425 in apprenticeships and 87 students on courses for high needs.

Historically our higher grade achievement for maths are above the national bench-mark at around 25% and last year was around 30% however that was under Centre Assessed Grades due to exams being cancelled due to the Covid 19 Pandemic. This year we expect a similar achievement rate due to the second year of exams being cancelled and are working with our awarding body to give teacher assessed grades.

In terms of the CfEM we are one of the 21 college 'Centres' and administer CfEM work with 7 partner institutions. Gateshead College normally runs multiple projects in a year with our team. This involves staff taking part in CPD and also running CPD for other institutions. Staff have worked on a variety of strands of research including IT, data and mastery.

College Goals

The goal Gateshead College sets for all its students is for them to leave with The Employment Edge. This means that once they have finished the qualifications they are completing with us, students will not only have the qualifications they need but also the soft skills needed to gain employment or move on to the next step in their training. Gateshead College sets high standards for its students in regards to excellence attendance and punctuality and also promotes equality and diversity with our PSD program as well as financial health, resilience work and work on career planning.

The students that were in the group for the action research this year were based over three of our campuses. At our Baltic Campus we included a group of business students and a group of IT/ESOL students, at our Skills Academy for Construction we included two groups of mixed trade students and at our Skills Academy for Automotive and Engineering we included two groups of Engineers. These students were mainly between 16-19 and studying courses between level 1 and level 2.

Research Aims

During the time working with the CfEM, the mastery approach to teaching has been a topic of interest for the college including our own staff's development of mastery as practitioners and delivering a mastery method to our post 16 students. The decision was made to carry on with that theme this year 2020-2021. However, given the Covid-19 pandemic, teaching was becoming more blended between online and in class learning due to teacher and student isolation and then, in the transition back to online learning due to the January lock down, the decision was made to see if we could apply mastery methods effectively in a virtual learning environment. Students had already become familiar with working on google classroom as part of the previous lock down or during their induction so it made sense to continue using google classroom as a base for the virtual sessions.

The topic of ratio was picked for numerous reasons, the main one being that in the previous year this topic had been delivered using the mastery approach in class so a comparison could be drawn between the previous year's success of mastery and the transition to delivering virtually. Ratio is also a topic that the students have historically struggled with and

it was being delivered across the college during this period so results could be directly compared between using traditional approaches to teaching ratio and the teaching of ratio using mastery. Ratio also lends itself well to using mastery approaches as it can be broken down into smaller steps and then built up on, represented in ways such as bar modelling to help students visual what is being taught and it can be connected to other areas of maths such as fractions. Staff also looked at what online tools were available to help with delivering this online and a combination of the following online tools would to be used – Google Forms, Jam Board, Quizziz, Desmos, Pear Deck, Maths Bot, Barton Diagnostic questions and Phet Colorado.

One of the essential aspects of the mastery approach is the time taken with the students to go back to the beginning of the subject so it was decided that ratio would be delivered over a half term with the initial assessment taking place before and the post assessment to be done after the break.

Literature Review

The aim of our literature review was to investigate what had been previously published on the implementation of the Teaching for Mastery approach in virtual classroom setting. For that purpose, our literature review included articles on the effectiveness of Mastery approach in Mathematics, as well as those that investigate the outcomes of the use of virtual resources in teaching, such as virtual manipulatives.

The term “*Teaching for Mathematics Mastery*” emerged in 2011, following the development of curriculum in Singapore. Since 2014, Teaching for Mastery has become the leading pedagogical approach in mathematics in schools in the UK and it is now extending into FE, aiming to improve the performance of all students. The reform has received significant support from the Department for Education through funding for the Shanghai-UK teacher exchange program and the forty Maths Hubs across the country as well as by enlisting the support of NCETM (England-China teacher exchange 2016/17: Seeing Shanghai teaching at first hand (NCETM, 2016).

The basic principle of Teaching for Mastery is that all students can learn mathematics, obtain a deep understanding of the taught concepts and achieve mastery at their own pace.

According to Guskey (2010) there are six core elements to the Teaching for Mastery model:

1. Diagnostic pre-assessment with pre-teaching,
2. High-quality, group-based initial instruction
3. Progress monitoring through regular formative assessment
4. High-quality corrective instruction
5. Second, parallel formative assessment
6. Enrichment or extension activities

The approach has been first implemented in an increasing number of primary schools and gradually introduced in secondary schools. Since the present action research refers to Further Education setting, we were considering published journal articles and reports that appeared closer to our students’ learning profile and needs. We took into consideration the outcomes of the Secondary Evaluation Report conducted by the Education Endowment (EEF) (Austerberry, et al., 2015). The project provided information on the Mastery approach experience of both teachers’ and students. The schools that applied Mastery approaches noted some progress, that was not statistically significant when compared to the control group. The report also refers to the limitations of the project, given that the research was conducted only for one year and was not able to track the long-term impact of the approach.

The report also refers to the cost effectiveness per pupil. However, one of the outcomes that appeared relevant to our present action research, was the increased use of manipulatives, with bar models the most popular choice of teachers. The report also underlines the need for teachers to further develop their skills and knowledge on the Mastery approach, including the use of maths manipulatives to support their teaching practices. Over the last ten years, both the Mastery approach and virtual learning are being expanded. The virtual learning and the use of virtual manipulatives in mathematics were already introduced in both primary and secondary schools. However, due to the pandemic, the virtual classroom has become the new reality in education that grows and expands rapidly. Online teaching is correlated to factors such as social, cognitive and teaching presence (Carrillo & Assunção Flores, 2020).

As we were reviewing the literature on Mastery and virtual learning, we realised that we could find journal articles referring to both topics separately, but not combined. We were looking for articles that investigated school settings that had already embraced Mastery approaches, and how they responded to the needs of virtual learning, while maintaining the standards and practices of the Mastery approach. The lack of such articles led us to focus on articles that describe the effectiveness of virtual manipulatives in teaching Mathematics.

Since the Mastery approach is based on the Concrete-Pictorial-Abstract (CPA) model, it is important to investigate how virtual manipulatives may be incorporated in that scheme. Lee & Tan (Lee Ngan Hoe, 2014) proposed the C-V-P-A where V stands for the transitional role of virtual manipulatives, from “concrete” to the “abstract” stage. Based on their case study, the use of virtual manipulatives resulted in narrowing the cognitive gaps, the significant improvement of student engagement, and the increased efficiency of lesson planning. Similar findings were discovered by Hunt, Nipper, Nash (Hunt, Nipper, & Nash, 2011). In their study, they compared the effectiveness of concrete versus virtual manipulatives. They highlighted the effectiveness of virtual manipulatives in bridging the transition from concrete to abstract stage, underlying through students’ experience and feedback. Students found easier to work concretely first, and then move on to the virtual use of manipulatives. In addition to the above findings, researchers found the use of particular manipulatives and methods from Mastery approach as very effective with students that struggle with mathematics. Morin, Watson, Hester, Raver (Morin, Watson, Hester, & Raver, 2017) report the effectiveness of the use of bar models on word problem-solving as an intervention method. The study involved just a small group of primary school students with learning difficulties in Mathematics. Their findings indicate significant impact on student development and maintenance of strategies and accuracy.

In conclusion, the findings of the articles we reviewed, encouraged us to proceed and investigate the application of Mastery approach in virtual classroom in Further Education level. Based on the literature review findings, we chose to use virtual manipulatives as an effective way to enhance students’ learning experience. Our focus was on bar modelling using e-resources, such as MathsBot. The literature review highlights bar modelling as an effective approach for all learners including the learners who struggle with mathematics concepts. The topic we chose to teach was approach was ratio and scale, along with other e-resources to support our teaching practices.

Methods

What is aims/objectives of the study and why did we choose it?

Education has been hit particularly hard by the Covid-19 pandemic; there was uncertainty about how classroom closures would impact students' achievement (in maths). Without the data at hand on whether and when students would return to in-person lessons, it was vital that their maths education would continue in a virtual setting.

Taking the situation education was forced into, the aim of this research was to see if Mastery methods could be applied within a virtual setting.-Especially important to investigate was the ratio module using methods such as bar modelling, which are normally used in a classroom environment.

Our objectives for the research were to include:

- Intergrade a virtual classroom for GCSE maths 'learners focusing on a mastery approach.
- Distinguish virtual platforms/software to support the development of maths through a home-schooling method.
- Review students' engagement and participation to their maths' education.

The action research study is descriptive and tries to understand the importance of, and 'what works in',-online learning in the period of pandemics such as the Covid-19. The problems associated with online learning and possible solutions were also identified based on feedback from quality systems, staff and students.

Who participated in the study?

The data collected was from a virtual setting and depended on online responses from students and staff alike. Participating in the primary research were 79 students and three maths' teachers. The students (groups) were selected by the researchers from areas which were either very strong/weak within IT literacy skills. This was to allow comparing students input/engagement within online activities. The students were from four curriculum areas with a minimum maths' ability of GCSE grade two; the table below shows the split between the groups

Curriculum area	quantity
IT	9
Business studies	13
Engineering	34
Construction	23

This action research study occurred over a seven-week period and involved one complete cycle of the action research process – problem identification, action planning, implementation, evaluation and reflection (Carl & Kemmis, 1986).

What methods were used to collect data?

This study is completely based on primary data and mainly Qualitative methods (Lincoln & Guba, 1985) were used at each stage of the study. The sources of data used are (a) Observations of learning, (b) focus group discussions, (c) student evaluations, (d) external partner (Cramlington School) questionnaires, (e) student questionnaires, and (f) feedback from the quality department. Qualitative data was collected from the formative assessments that the students completed, although this formative assessment data cannot be compared to any previous results so the qualitative data will only be used for analysis.

In response to the coronavirus (COVID-19) pandemic, we adapted our approach and looked for methods which could be collected via a virtual setting. Educational online programmes

were introduced and became easier due to repeated use; evidence of their input to learning was captured through student evaluation and feedback.

Ethical Considerations

Due to the (COVID-19) pandemic, this study progressed from establishing our current thinking/practice (classroom setting) to collaboratively designing and trying out improvements within a complete virtual setting.

Students were informed at the start of September regarding the College's engagement with CfEM and student-participants were given a brief description of the research plan and were asked to give permission to participate. Their identities were protected using a coding method (student unique number) and the data was stored on a password-protected system. Mertler (2014) argued, "An action researcher's ability to ensure anonymity and confidentiality of participants and their data is a vitally important component of the action research process and of any action research project" (p. 151).

Classroom sets of laptops (Chromebooks) were also provided during the virtual learning period throughout the study to ensure all students had access to their maths' lessons. However, the materials used in the live lessons were uploaded and shared so available for students any time during the day when at home. No participants indicated a lack of Internet accessibility outside of the classroom.

Results and discussion

Findings

At the start of this action research the teachers involved attended a collaboration meeting and agreed a revised scheme of learning (see appendix two – first example of the scheme of planning and early amendments discussed in meeting) which also included reflective data collection plan (appendix one- plan for data collection in lessons).

Learning walk

The first piece of evidence created was a learning walk questionnaire using google forms – each teacher had a cycle of 3 teaching observations which were conducted by the quality team within the college. The learning walk (observation) was virtual and a standard list of questions were answered. Students were interviewed by the quality team at the end of every observation to collect learner voice linking to their virtual progression. (See appendix 5 for questionnaire template.)

The findings from each learning walk were shared with the teachers; overall participation and interaction from students was noted as very strong and the pace of learning/tasks was also seen as a key strength. Points identified for further consideration were particularly around individualised support to students and the lack of cameras being used by the students. Student voice was referred to as “exciting” as they shared their thoughts around different technology methods being used – although 1 in 3 students did say their lessons were difficult due to being stuck with their technology issues – comments such as “I didn’t know how to download docs into my classroom” amplified the need to ensure students’ personal technical development is addressed alongside their teachers when using new programmes.

Student voice gathered from the construction students was particularly interesting – 45% stating that they disliked virtual classes – finding them frustrating, “I just want to go back to my classroom lessons” was common throughout the research learning walks.

Student (using technology in the lesson) Evaluation

Another example of lesson evaluation with google forms was a questionnaire for students to complete. The purpose for this evidence was to evaluate the new programmes being used in the education setting when creating/using manipulatives virtually. (See snapshot of form below.)

What technology has your teacher asked you to evaluate? (if unsure ask your teacher before completing this form) *

Short answer text

On a scale 1 to 5, how easy was it to use? *

Awkward - I struggled 1 2 3 4 5 Really easy

On a scale 1 to 5, did it improve your understanding to the taught subject? *

Not at all - I'm still confused 1 2 3 4 5 Yes, I have more understanding

(Summarize) What was your lesson about today? *

Short answer text

Using this technology in my lesson enhanced: (click all that applies to you) *

Copy of Technology feedback

Questions Responses

What technology has your teacher asked you to evaluate? (If unsure ask your teacher before completing this form) *

Short answer text

On a scale 1 to 5, how easy was it to use? *

1 2 3 4 5

Awkward - I struggled Really easy

On a scale 1 to 5, did it improve your understanding to the taught subject? *

1 2 3 4 5

Not at all - I'm still confused Yes, I have more understanding

((Summarize) What was your lesson about today) *

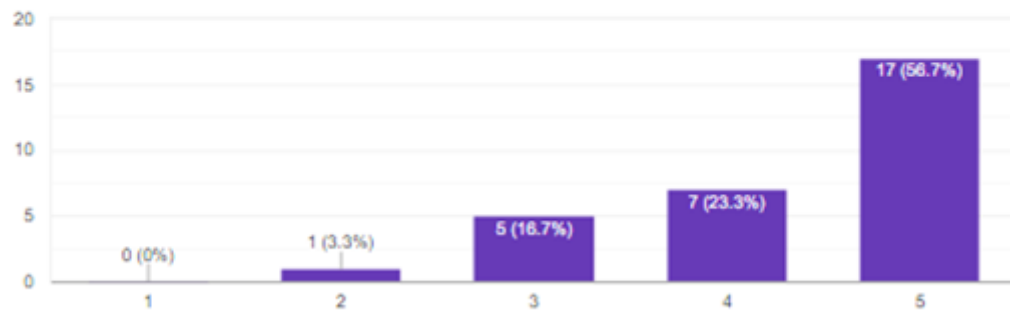
Short answer text

Using this technology in my lesson enhanced: (click all that applies to you) *

These forms were circulated to every group at the end of each lesson. Students were asked to evaluate (anonymously) the technology used against their learning outcomes. The results were collected and discussed with students. Lessons and methods were adapted against the feedback received – below is a snapshot of feedback results.

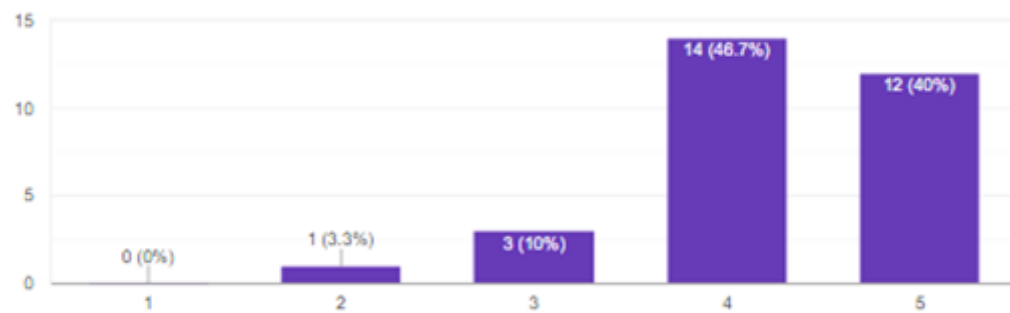
On a scale 1 to 5, how easy was it to use?

30 responses

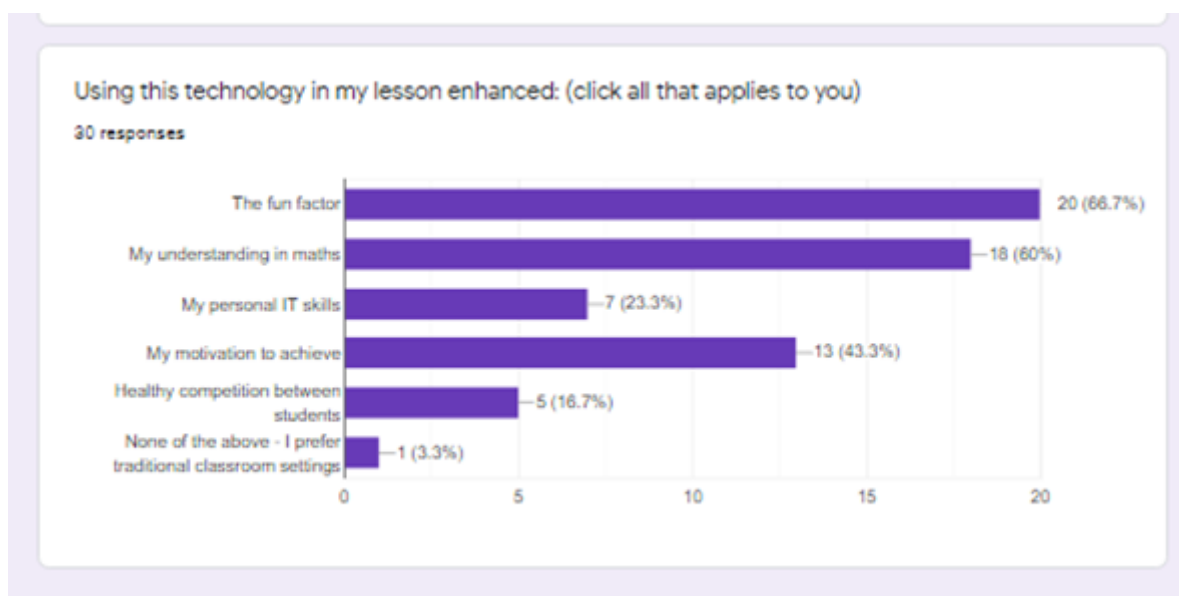


On a scale 1 to 5, did it improve your understanding to the taught subject?

30 responses



(Comments) All but one user found it to be...



External meeting with Cramlington Learning Village

Cramlington LV is a comprehensive school in the North East that has been involved in maths mastery since 2016. Students in year 7,8 & 9 are learning maths through the mastery approach and their teachers have become important leaders within these methods & approaches. Recognised throughout their recent Ofsted report, their key strengths are use of manipulatives, talk in lessons (interaction), students' problem-solving skills and overall attainment.

One of their mastery leads is a teacher called Helen; it was important to our research that we spent time gathering evidence from external partners to see how they were coping with mastery maths during the pandemic and how they were overcoming their barriers to teaching. We attended zoom focus meetings with Helen and colleagues and shared common findings such as frustrated students, lack of face to face contact and minimal availability to individualised formative assessment.

A key message was focusing on staff development/support throughout and the need for more regular team discussions. Staff agreed that the normal classroom-based activities were a challenge online although programmes such as Mathsbot, Desmos and Jamboard seemed useful. Students' input into their lesson approach was seen as a positive focus from all teachers however one teacher in particular found it very difficult to manage the progress of learning-when working virtually in maths and felt that some students would fall behind.

It was suggested that although maths mastery techniques had been a struggle in a virtual world, considerations would be adapted in future planning to include a blended approach with more frequent use of online programmes.

Student input into lessons

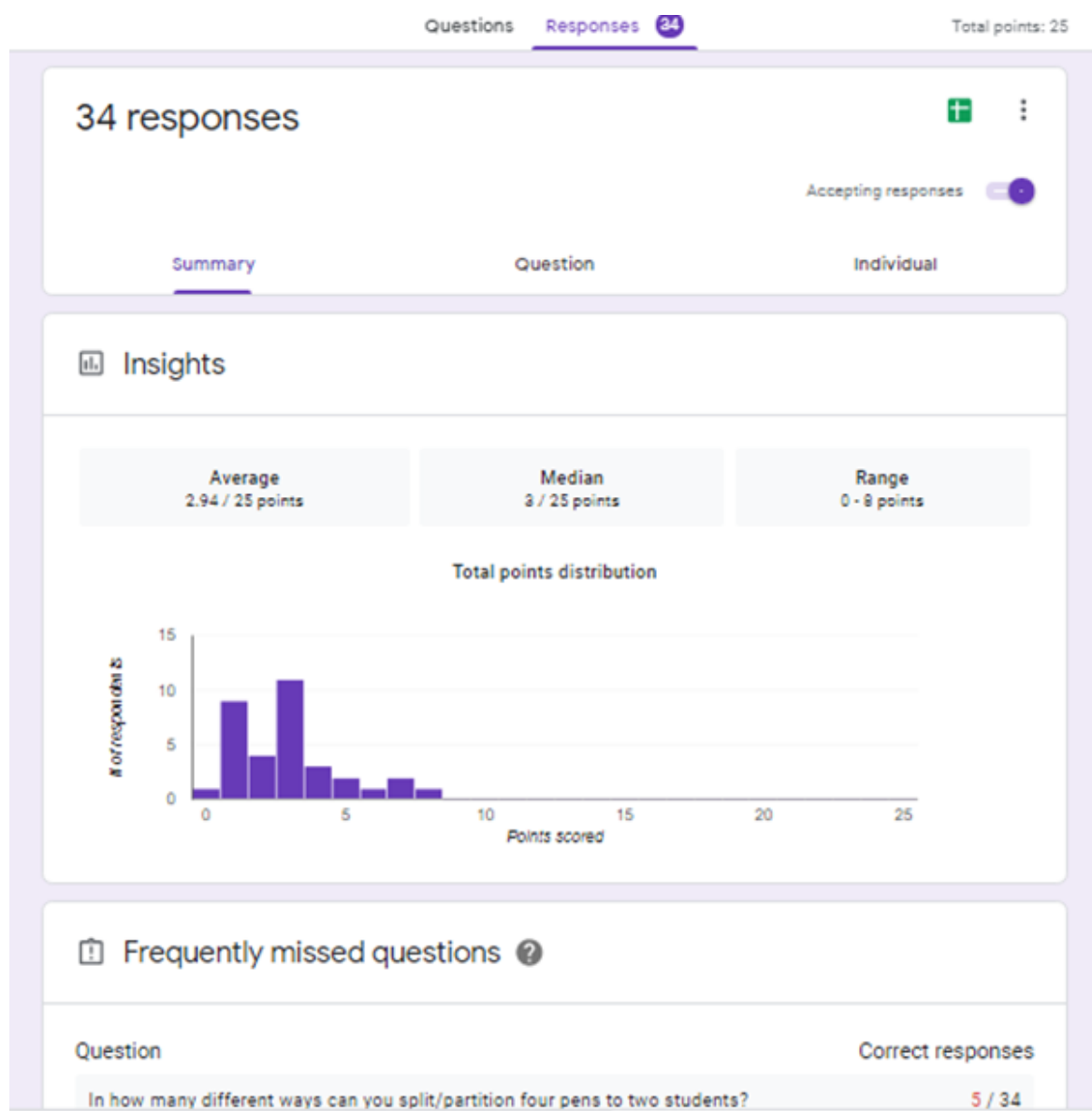
Each virtual lesson followed the usual timetable as their classroom setting – this was decided by management to ensure students knew in advance what lessons they had. It was noted through attendance monitoring that early morning lessons (9am) had a lower attendance rate to the later lessons- students in these early sessions were monitored closely through in-depth virtual connection and supportive plans.

Students had access to their Google classroom; this classroom was used for sharing materials, videos, communication and where students would submit their work for marking. Each lesson was delivered through Google Meet; a link to this meet was provided in advance to students on their Google classroom stream with a pre-lesson activity. These activities were based on essential skills in maths and ensured prior mastered skills (such as using fractions and percentages) did not deteriorate. Mastering maths in previous skills is ongoing. (See appendix three.)

Students submitted their essential skills for marking prior to the lesson – feedback was provided immediately – this developed an ongoing connection to their maths' teacher and increased ongoing support. (see appendix four – tracking of feedback to students using google classroom matrix).

Pre-Assessment

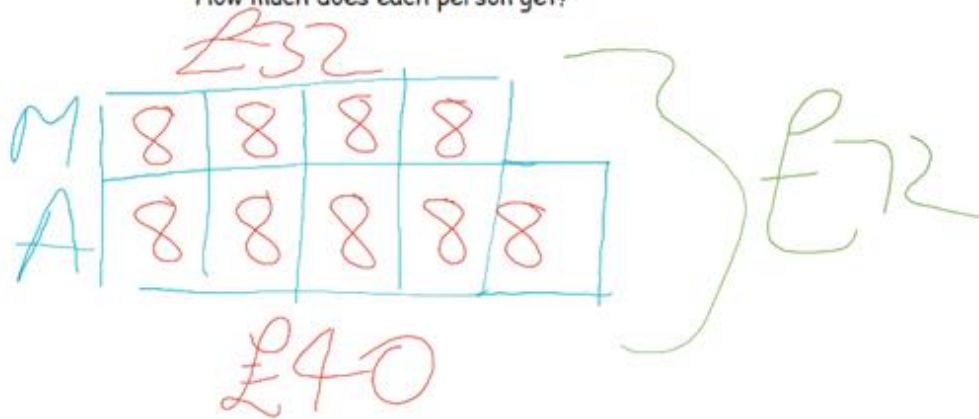
At the start of the action research we assessed the student's' skills in ratio and their ability using IT. This assessment was virtual using google applications and 34 students submitted their responses. Out of these responses the average score (out of 25) was 2.94 and the range was 0 – 8. This was surprisingly very low however this was completed by our construction students who have historically struggled with technology.



Resources

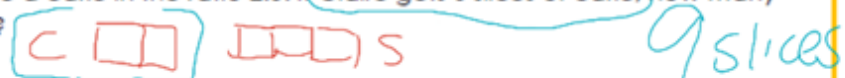
Jamboard – an interactive whiteboard was created and shared with students – each student had their individual jamboard which they worked on during their lesson (see students' attempts below). Surprisingly when evaluated every student enjoyed using jamboard; on a ratio of 3:5 said it was fun to use, 2:3 said it was easy to use, 4:5 said it helped them understand ratio parts by using pictorial.

Maya and Amit share £72 in the ratio 4 : 5
How much does each person get?



Non-routine

a. Claire and Sue share a cake in the ratio 2:3. If Claire gets 6 slices of cake, how many slices does Sue get?



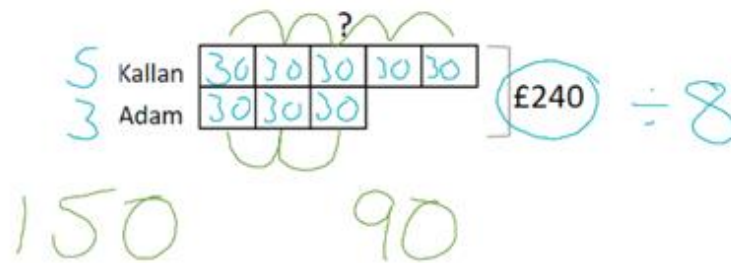
b. Keith and Frank share some money in the ratio 3:7. If Frank gets £24 more than Keith, how much does each person receive?



c. Rita and Pauline have some sweets in the ratio 3:2. Rita gives Pauline 12 sweets. The ratio of sweets is now 1:4. How many sweets are there in total?



Kallan and Adam share some money in the ratio 5 : 3
 Between them they have £240
 How much does each person receive?



Paul, Liam and Drake shared some money in the ratio
 2 : 4 : 5
 Drake got £21 more than Paul.
 How much did Liam get?



Peardeck

Peardeck is an interactive PowerPoint presentation which students could access from their device to input directly in the slides. Each student receives a copy of peardeck and all input can only be seen by the teacher unless it is agreed to share with other students. Their input can be downloaded as a pdf at the end of the lesson and shared back with the student. This was very useful for referring back to and supporting their development.

Slide 7	Your Response	Slide 8	Your Response
PROPORTION -  What is the ratio of red to green? Answer 1: 3:4 Use this space to take notes:		PROPORTION - WHAT WOULD HAPPEN IF I DIVIDED 15 BY 3 & 20 BY 10?  What is the ratio of red to green? 15:20 Answer 1: 3:2 Use this space to take notes:	

Slide 7	Your Response
PROPORTION -  What is the ratio of red to green? Answer 1: 3:4 Use this space to take notes:	
Slide 8	Your Response
PROPORTION - WHAT WOULD HAPPEN IF I DIVIDED 15 BY 3 & 20 BY 10?  What is the ratio of red to green? 15:20 Answer 1: 3:2 Use this space to take notes:	

Slide 10	Your Response
Mays and Amit share £72 in the ratio 4 : 5 How much does each person get? 	Mays and Amit share £72 in the ratio 4 : 5 How much does each person get? 
Use this space to take notes:	
Slide 11 Paul, Liam and Drake shared some money in the ratio 2 : 4 : 5 Drake got £21 more than Paul. How much did Liam get?	Paul, Liam and Drake shared some money in the ratio 2 : 4 : 5 Drake got £21 more than Paul. How much did Liam get? £28

Other Resources

Other resources that we used were the following:

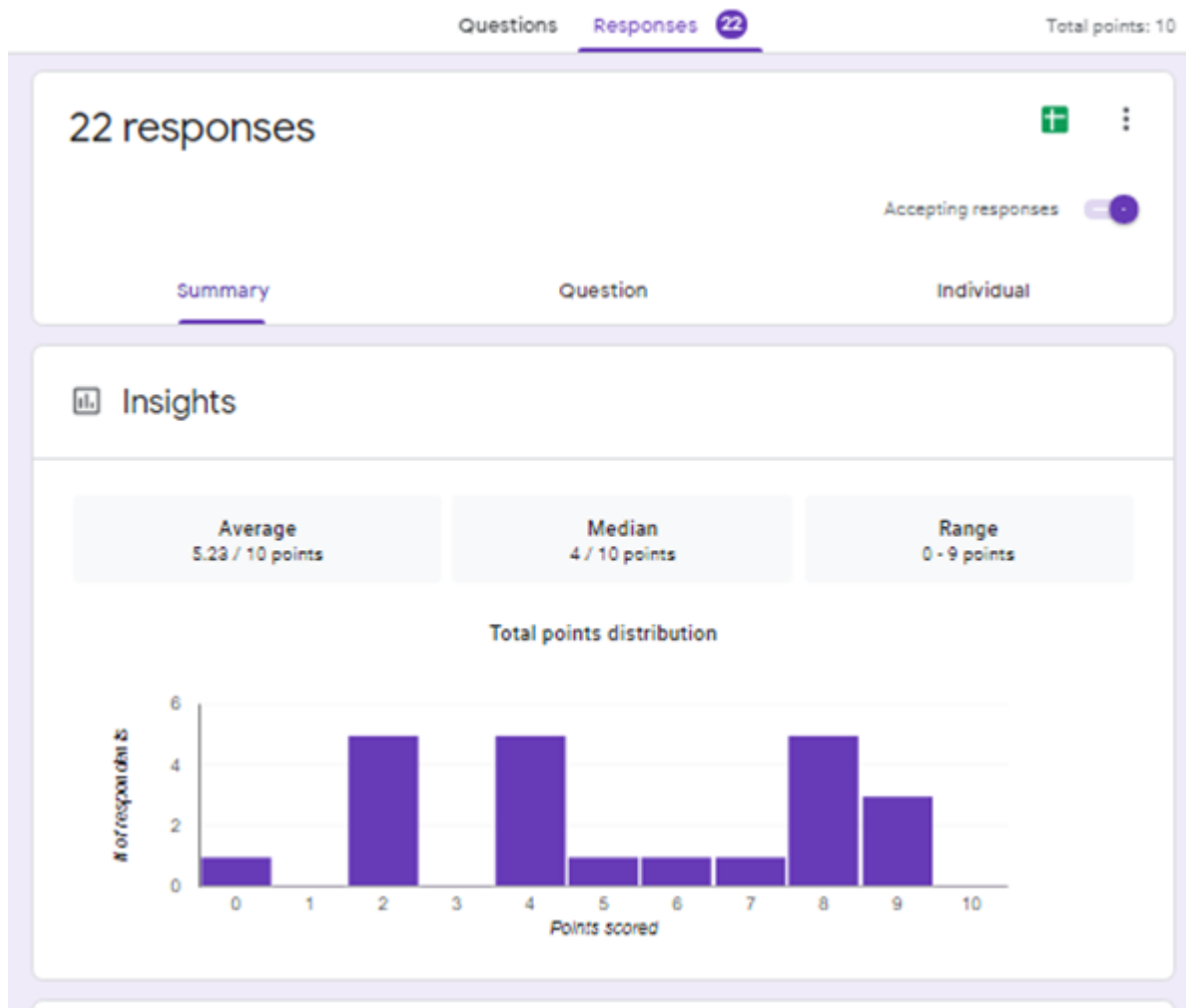
- Quizziz – online team quiz where devices are used live in lesson
- Desmos – interactive website
- Mathsbot – interactive website developing skills
- YouTube videos from mathsantics which has ongoing activities and pause points to allow students to interact and not just watch.

It was important throughout this action research that we focused on keeping students active and learning together.

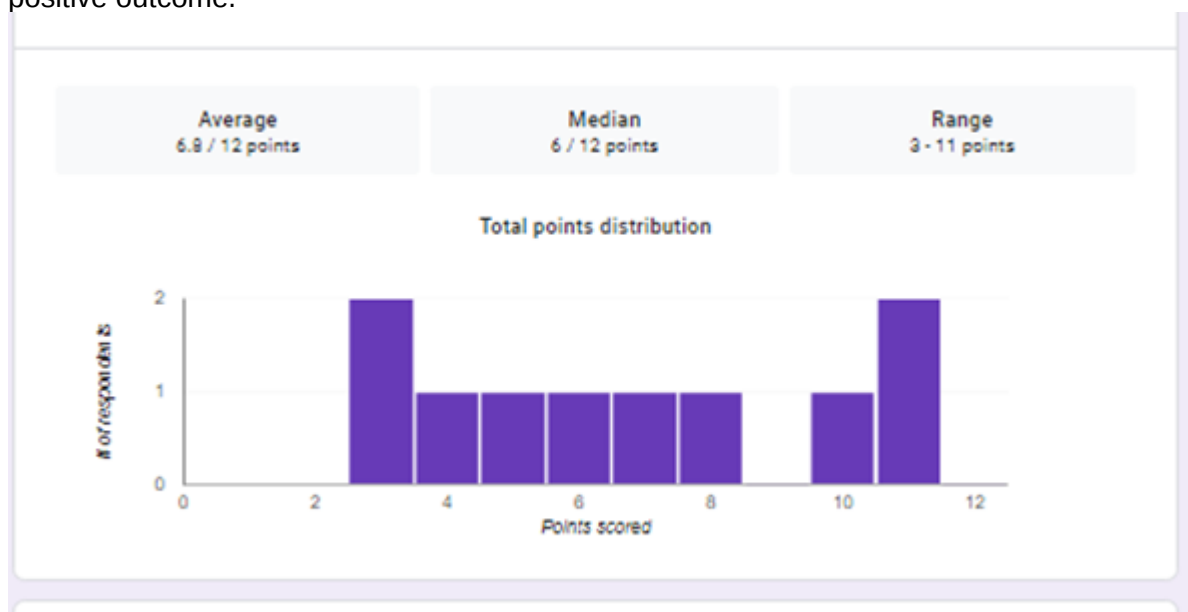
3-point assessments

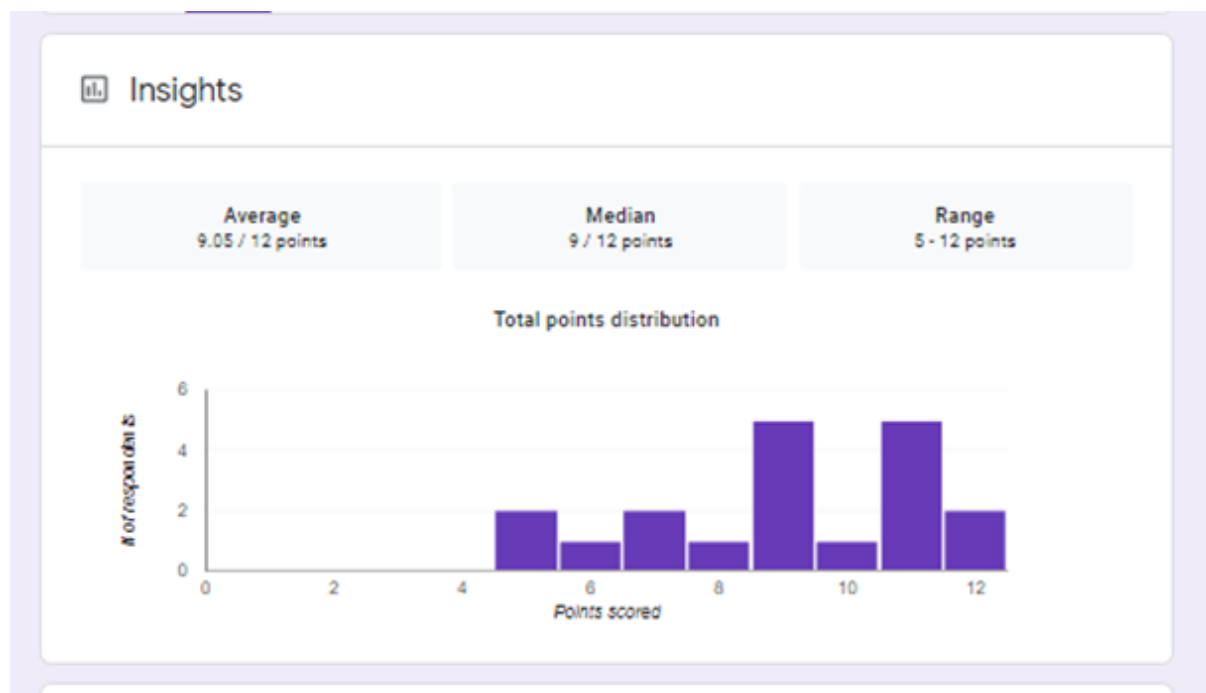
The scheme of planning included 3 assessment points – each assessment was created on google forms where results were analysed throughout. The assessments looked at the previous lesson topics and the following results were found:

Assessment one – Only 22 students participated in this assessment; other students failed to interact. Out of these 22 students, the average score of the group was 52%.



Assessment two – This assessment was completed by 29 students – there was a slight improvement on the average score and the minimum score increased overall which was a positive outcome.





The positivity of the technology evaluation questionnaires completed by the students also increased around this time which could be linked to the increase in results. Reflecting on the student's responses shows that motivation increased with confidence.

Assessment three – The final assessment was completed by 34 students – this was completed in the classroom but submitted online. It was very interesting to see that the overall average score increased to 68%, where 11 out of 34 students scored 100%.

	Apr 21	1
	Ratio	4
	yellow	-
	out of 100	6
	66.74	4
n Khan - S...	100	4
	Not turned in	
Score - Stu...	100	4
	Not turned in	
ny Monar...	100	4
	Not turned in	
urnbull - ...	100	6
	Not turned in	1
don Miller ...	0	4
	Not turned in	
	100	6

Focus groups

For our final piece of evidence, we held focus groups – these groups were held in college as the pandemic lockdown started to ease and students returned to college. The focus groups were offered to all students and were attended by students of mixed ability/background/gender.

The conversation was started with a quick introduction – focusing on two key topics – using manipulatives in development and using technology as the main source. Over three-fourths of the students said they liked doing the activities (manipulatives) and agreed that it would've been more fun doing this in class

S1: why do you think it would be more fun?

S2: I like group work – virtual isn't groupwork

S3: yeah helping each other and trying to get the answer

S1: mmm it was a bit isolating being stuck at home

S3: when you compare answers together and see who's right/wrong it helps us understand it more.

S4: yeah, you can't do that online cos there's too much talking

S2: I'm easily distracted at home – it's boring sitting in front of a computer.

S5: Teachers don't talk like us, in our language, and when we talk to each other it's easier to understand

S3: I enjoyed the bar models, ratio makes more sense cos I can visualise it now

S1: yeah, I liked Peardeck – we should use it again. It was fiddly at first but I'm okay with it now

S6: my favourite was looking at the wordy questions differently – I like the bar modelling, I'd rather draw them than trying to use a mouse

S2: I'm glad we're back, technology is good if you know what you're doing but it stressed me out a bit.

It is obvious that the FE students prefer to be actively involved in the lesson and working with each other closer than virtual. I also found from the evidence that students attitudes improved towards lockdown education – attendance improved.

As teachers we found that the overall results lead us to look for more ways to incorporate manipulatives into our lessons. Students on a whole enjoyed maths more as a result of using manipulatives however socialization with their peers did suffer.

The results for attitude mimic those of Sowell (1989) in which she found that concrete materials when used in extended learning structures were beneficial to student learning. It is apparent that students not only gain valuable experiences from using the manipulatives, but also it allows them to create their own understandings and affords them the socialization (when not in a pandemic) that FE students desire.

From this action research we (Gateshead College) intend on sharing our findings with our colleagues both in FE and further afield about the effects that manipulatives had in our virtual classrooms. It is our intention to create a presentation sharing a sample of our lessons that other teachers can take and use in their own classrooms.

Conclusions and recommendations

Conclusions

During this recent pandemic, schools, colleges and universities faced lockdowns. Many academic institutions— similar to Gateshead College were constantly seeking ways in which online learning (teaching and learning processes) was not hampered.

The challenges posed by the pandemic introduced everyone to a new world of online learning and remote teaching. The researches within this study used platforms such as google and zoom and throughout this study, the importance of learning taking place, was at the heart. Teaching students mastery techniques which are traditionally classroom based was a challenge – but a challenge we seized in both hands. Using the SWOC analysis method, below is our conclusion to this study.

SWOC (Note. SWOC = Strengths, Weaknesses, Opportunities, & Challenges).

Strengths

The strengths from our action research:

- E-Learning methods and processes are really strong including a robust support from the IT department.
- It is student-centred and offered a great deal of flexibility in terms of times and location.
- This study showed that there are plenty of online tools, which is important for an effective and efficient learning environment.
- Teachers' motivation in adapting new techniques increased and constant communication between teams flowed well with ongoing reflection throughout.
- The use of google meet maintained the human touch to lessons. This helped to create a collaborative and interactive learning environment as well as immediate feedback, opportunities to ask questions and keep the learning real.
- Technology provided innovative and resilient solutions at times of crisis to combat disruption and helped people to communicate and even work virtually without the need of face-to-face interaction. This led to many system changes in organizations as they adopt new technology for interacting and working (Mark & Semaan, 2008).
- Ofsted monitoring visit – The visit focused on the action being taken to provide effective education during pandemic situation. Some lessons were visited remotely by inspectors with a positive outcome.

Weaknesses (to mastery online)

- Students found it difficult to transfer a skill from traditional pen/paper to online software; E.g. drawing a bar chart on paper to creating a table using word or docs.
- Students' behaviour in terms of time and flexibility caused a lot of problems especially lateness delaying some learning progression.
- Direct communication and human touch between students were lost – lack of 1-2-1 questioning and guidance during group lesson time was weak which caused problems when developing their mastery goals. These goals ~~which~~ are aimed at improving one's own performance and gaining full mastery of the task or subject.
- IT capability varied in students and staff and needed a lot of consideration, support and development time to ensure engagement and interaction was achieved. Users can face many technical difficulties that hinder and slow-down the teaching-learning process (Favale et al., 2020).
- All students are not the same, they vary in capabilities and confidence level. Some do not feel comfortable while learning online, leading to increased frustration, anxiety

and confusion and feeling uncomfortable to switch on their camera – making the communication more difficult.

- Assessing engagement and capability from body language was missing so relied on responses to questioning and tasks.

Opportunities

- Virtual learning has a lot of opportunities available, and this pandemic has forced teaching models, such as mastery, to switch this way. Online Learning, Remote Working, and e-collaborations exploded during the outbreak of Corona Virus crisis (Favale et al., 2020). Education institutions must grab this opportunity by making teachers teach and students learn via online/blended methodology. Teachers are normally complacent and shy away from trying some new modes of learning. This pandemic has allowed teaching in the maths department to look at maths methods differently and how technologies can be used for the benefits of learning.
- This is the time when there is a lot of scope in bringing out surprising innovations and digital developments and there are a lot of companies out there that support education such as EdTech. Online learning tests both the teacher and learners and this study has shown it enhances problem-solving skills, critical thinking abilities and adaptability among the students. Further studies from Ofsted show that by using technologies in the classroom we are developing the rounded student and enhancing job skills. It is an imperfect but necessary substitute in mitigating against learning loss where classroom teaching is not possible. Pupils are still learning more than they would without any school support- (Ofsted, 2021).

Challenges

- It was a challenge to engage students and make them participate in a 'different way' of learning maths. It was a challenge for teachers changing their methodologies and putting in that extra time in researching new platforms. It was a challenge for teachers and students learning how to use the technologies and supporting each other when things went wrong. One thing we can take away from all these challenges – teachers can present the mastery methods in various formats such as videos, audio, programmes and live platforms. The biggest challenge was maintaining a personal connection with the students.

Recommendations

The goal of this action research was to see if mastery techniques can be used in a virtual world. Virtual learning in maths is different from the traditional classroom and during this research our scheme of learning was viewed differently. We had to take into consideration the environment, methods, ideas and the slower pace taken by students to learn. You have to find new ways to get a feel for how the students are doing; most of all, are they comfortable using a computer?

Some good and probably obvious ideas to develop virtual mastery maths techniques would be to:

- Talk to other teachers who are teaching similar topics/approaches
- Get ideas from educational departments outside of the normal setting
- Training with software and hardware is vital; this training should include students – using a blended approach where technology could start with homework to develop their confidence
- Most of all, remember to have fun. Explaining to students in advance what you are trying to achieve and how their views are important to the development of their learning. Students will understand and admire you more for trying something new if you involve them in the process.

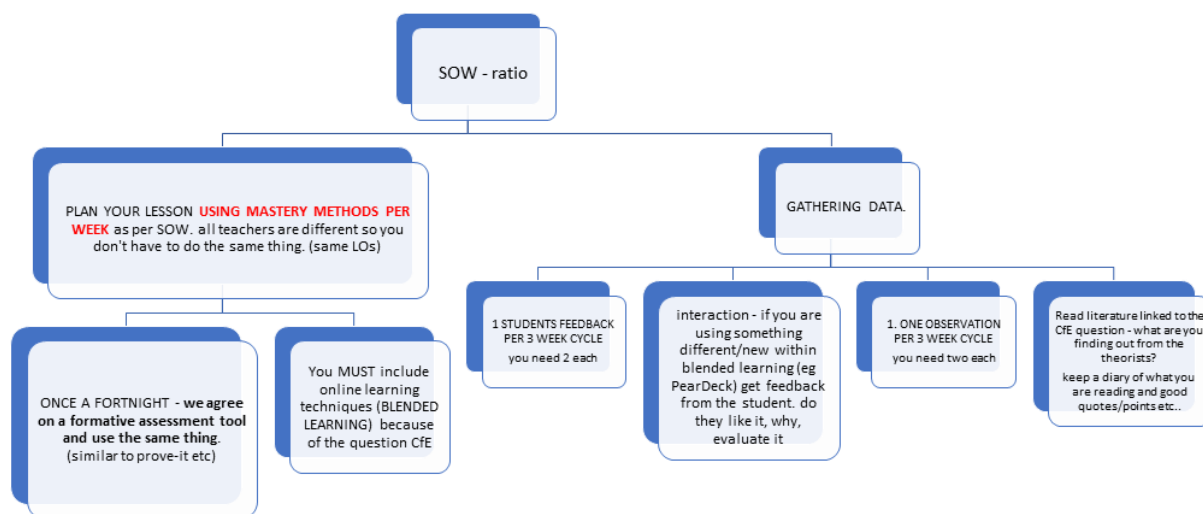
- The outcome from this study will develop the maths' teachers at Gateshead College (and in FE) to make informed decisions regarding the implementation of technology use in their maths classrooms. It will enhance student learning through flexibility and development and will make them more attractive to the employment market.

References

- Austerberry, H., Jerrim, J., Crisan, C., Ingold, A., Morgan, C., Pratt, D., . . . Wiggins, M. (2015). Mathematics mastery: secondary evaluation report. Education Endowment Foundation.
- Carl, W. & Kemmis, S. (1986) *Becoming Critical: education, knowledge and action research*. Basingstoke: Falmer Press
- Carrillo, C., & Assunção Flores, M. (2020). Covid-19 and teacher education; a literature review of online teaching and learning practices. *European Journal of Teacher Education*, 466-487.
- England-China teacher exchange 2016/17: Seeing Shanghai teaching at first hand|NCETM. (2016, 11 22). Retrieved from [ncetm.org.uk: https://www.ncetm.org.uk/features/england-china-teacher-exchange-2016-17-seeing-shanghai-teaching-at-first-hand/](https://www.ncetm.org.uk/features/england-china-teacher-exchange-2016-17-seeing-shanghai-teaching-at-first-hand/)
- Guskey, T. (2010). Lessons of Mastery Learning. *Educational Leadership*, 68(2), 52-57.
- Hunt, A. W., Nipper, K. L., & Nash, L. E. (2011). Virtual vs. Concrete Manipulatives in Mathematics Teacher Education: Is One Type More Effective Than the Other? *Current Issues in Middle Level Education*, 1-6.
- Lee Ngan Hoe, T. B. (2014). The role of virtual manipulatives on the Concrete-Pictorial Abstract approach in teaching primary mathematics. *The Electronic Journal of Mathematics and Technology*, 102-121.
- Lincoln, Y.S. & Guba, E.G. (1985) *Naturalistic Inquiry*. Beverly Hills: Sage
- Mertler, C. A. (2014). *Action research: Improving schools and empowering educators*. Los Angeles, CA: Sage
- Morin, L. L., Watson, S. M., Hester, P., & Raver, S. (2017). The use of a Bar Model Drawing to Teach Word Problems Solving to Students with Mathematics Difficulties. *Learning Disability Quarterly*, 91-104
- Ofsted. (2021) 15/07/21 <https://www.gov.uk/government/publications/remote-education-research/remote-education-research#future-benefits-to-remote-education>

Appendix/Appendices

Appendix one (planning) Action research



Appendix two

Meeting – 03.04.2021

We need to make changes please to this SOW

Week 1 Lesson 1	Introductions / Pre -assessment
Week 1 Lesson 2	HCF
Week 2 Lesson 1	Writing and sharing ratios/bar modelling intro
Week 2 Lesson 2	Sharing Ratios with Bar Modelling
Week 3 Lesson 1	Finding Missing Quantities
Week 3 Lesson 2	Finding Missing Quantities
Week 4 Lesson 1	Best Value
Week 4 Lesson 2	Scale Drawing
Week 5 Lesson 1	Scale Drawings
Week 5 Lesson 2	Pre- assessment repeat and test

As discussed

Thankyou

Start of week 3 lesson 1 – first assessment – intro to ratio (alongside the finding missing quantities)

Week 4 lesson 2 – best buys (again) push back scale drawing

Week 5 lesson 1 – second assessment – best buys – followed on by the start of scale drawing

Week 5 lesson 2 scale drawing continuation

Week 6 lesson 1 scale drawing assessment followed by ratio advanced (this could be a mixture of all)

Week 6 lesson 2 – continuation of ratio advanced finished off with end assessment/test etc – I think we should use a prove it which will be the same for all students to compare. Can you create this mix-up ratio assessment please.

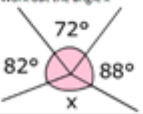
Thankyou

Appendix three

Gore - Student - 1 Essential Skills week 21a .docx ☆ 00 00

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Essential Skills week 21a		Working out: 1 Mark	Answer: 1 Mark
1	Find $\frac{1}{5}$ of £25		£10
2	Calculate 30% of 320kg		96kg
3	Write down the value of $\sqrt{25}$		5
4	Simplify $3b \times 4c$		12bc
5	What is the reciprocal of 3		0.3
6	Work out the angle x 		118
7	What is 0.2m in cm?		20cm
8	Calculate -3×-5		15

Appendix four

Stream	Classwork	People	Grades
Feb 12 Essential skills out of 100	Feb 10 essential skills out of 100	Feb 3 essential skills out of 100	Feb 12 Essential skills out of 100
0 Not turned in	0 Not turned in	0 Not turned in	0 Not turned in
60	30	50	60
95	87.5	85	90
70	82.5	75	85
80	0 Not turned in	60	0 Not turned in
80	75	—/100	85

Appendix five

Learning walk

This form provides you with feedback on your recent supportive learning walk. The learning walk will focus on student engagement and the use of technology used in your lesson to support the learning of students in a virtual environment.

Name of Observer *

Short answer text

Name of staff *

Short answer text

Class *

Short answer text