CENTRES FOR EXCELLENCE IN MATHS

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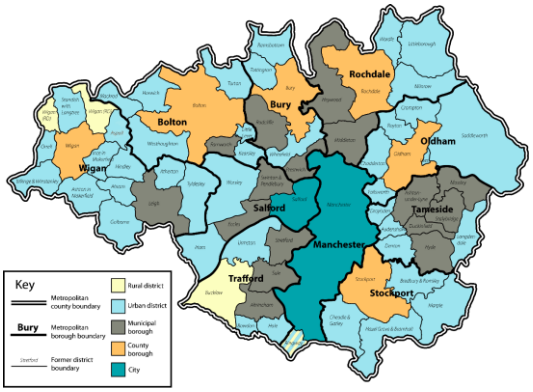

Raising attainment in level 2 students by developing an effective mastery model of intervention which fosters a positive mind-set by increasing learner confidence

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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

Following the Wolf Report (2011) recommendations that young people without good GCSEs should continue studying maths and English post-16 the government introduced the condition of funding policy (2014). Placing a lens on Further Education (FE), the GFE (General FE College) average of 17% and statistics from 2019 reveal that fewer than a quarter of maths entries from candidates aged 17 and over across the UK gain a pass at grade 4 or better from their resit and with pass rates in Maths dropping from 23.7% in 2018 to just 22.3 per cent (Joint Council for Qualifications, 2019). It is then no wonder that so many of the students come to us with low career aspirations and barriers to learning.

This report begins by examining theoretical perspectives from current literature to analyse the links between these barriers to learning and poor motivation and mindset. This then leads to the primary research to investigate how an adapted mastery teaching model can assist in overcoming these impediments to learning.

Through using an ethnographical action research which focuses on 400 resit students, 25 maths teachers and 30 vocational staff, this report demonstrate how attainment in level 2 maths can be improved by develop an effective mastery model of intervention which fosters a positive mindset and increases learner confidence.

By illuminating the role that the mastery model plays in developing a growth mindset in maths, authors are then able, through their findings, to make meaningful recommendations as to how the research results can be embedded into college and departmental practices.

Contents

Background

Introduction

The college undertaking this project, Tameside College is situated in the East of Greater Manchester. From the 141 areas in Tameside, eight of these fall within the most deprived 5% nationally and a further 16 fall within the most deprived 10% nationally. In total, 13.4% of Tameside residents live in income-deprived households (Tameside Council, 2020). Tameside College is one of the 21 centres across the country to carry out action research as part of the CfEM programme, whilst extending the research to our network partner colleges.

In order to best understand and therefore inform and narrow the focus of the research proposal, it is necessary to examine and evaluate the changing landscape and challenges faced in teaching the maths resit in FE. Traditionally maths teachers in FE teaching the resit course face the cognitive dissonance between covering the Maths content and taking the time to develop understanding (Swan, 2006). This discord has become even more pronounced since the advent of the reformed 9-1 GCSE examinations where the increased subject content directly contradicts the published general criteria i.e. to not overload the syllabus (Roy, 2019). It is no wonder then the majority of GCSE Maths teaching has conventionally focussed heavily on memorisation of rules and procedures and rote learning reaffirming learners' attitude and beliefs about maths and furthering disaffection (Dickinson et al.; 2010; Boaler et al., 2000; Dalby, 2013).

Statistics show that resit examination success rates are poor. 2012–2017 results show that between 2012 and 2016 an average of just 8.6% of students leaving school at age 16 without an acceptable pass in GCSE mathematics went on to achieve an acceptable grade during 16–18 education, with a rise to only 13.3% between 2016 and 2017 (DfE, 2018). For a deeper analysis and to explore maths teaching within FE further, it is also useful to note how FE resits results lag behind other providers.

GCSE Maths 16-18	2018	2019	change
4+ pass rate – All providers	18.2%	17.4%	-0.8%
4+ pass rate –Further Education	17.6%	15.0%	-0.8%

College Goals and Our Learners

The unemployment rate for the Tameside region is slightly above that for the North West region and above the national average (Tameside Government website, 2020), so improving employment prospects are a key part of the college's goal to 'transform lives by offering first class education and training in order to improve employability' (Tameside College, 2021). The focus for the action research must consider how it will add value to developing strategies to ensure that all young people are given opportunity to achieve highly valued qualifications in maths.

The number of students in Tameside schools achieving GCSE grades 9 to 4 in both English and mathematics remains below the national rate (Ofsted, 2018). Local policy recognises that some schools are still struggling to narrow the gap between the attainment of those eligible for free school meals and others. The MiDAS report on Tameside College (2019) shows that nearly 40% of all learners come to college without a pass in GCSE maths and English, a further 16% have an English GCSE only and only 7% of students have Maths GCSE only. This again is consistently below the GFE pass rate. In real terms this means that many of our students often have poor previous experiences of school, low career aspirations and maths in particular is seen as being "not for them". This is further compounded in our progressing students who may be undertaking a resit for the second or third time. It is then no wonder that so many of the students come to us with low career aspirations and barriers to learning Students coming into the college are increasingly aware of the value of a GCSE in maths and its importance to employers but often cannot see how they can bridge that gap between where their maths is now and where it needs to be in order to gain advantage and traction in today's job market.

Research Focus

It is important to us to continue with classroom practitioner enquiry. As we have progressed, our understanding of action research (AR) has enabled us to focus on the interaction between the learner and the practitioner. Early indications, albeit with incomplete data collection and analysis from our previous year's research, showed that the intervention within the mastery model was starting to bring about progress in both engagement and mathematical progression in our students. However, even with the Covid -19 interruption we were realising that our initial research question had too many strands making deductive reasoning difficult and the systematic enquiry leading to the outcomes too broad to orchestrate understanding.

This has led us to rationalise the need to narrow the research focus. This had to be carefully considered so that the original concerns and the lens that informed the initial AR question did not become lost or over diluted. At the same time, by recognising the need to tighten the parameters adequately, the correct methods of data collection analysis can now be planned. Initially the AR examined the question 'How do teachers operate intervention for GCSE re-sit students with a Mastery Approach?' However, the multiple perspectives in play meant that this question was too over simplistic and thus became a topic to investigate rather than a focused question to allow the researchers to get a deeper understanding of the actual issues. It was agreed during the period of reflection, that in order to elicit a better understanding and in order to create the improvement that we needed, it was imperative that

we built on and learnt from the work done. This meant that we needed to undertake an iterative process and adjust our question and make this more specific. Fundamental to forming the new question was the determination of how we defined intervention. In the development of the original question, this was not sufficiently defined and so although the AR had various strands, these did not have distinct objectives linking to an overarching theme. In this reiteration, we have carefully designed the objectives to ensure that we can answer the research aim and that it is clear not only what intervention we are carrying out but also who the intervention pertains to.

What was also becoming more apparent was that by also addressing motivation alongside the mastery model, it became clear that mindset was underpinning any intervention model trialled. This meant that questions such as ‘is it the actual model of maths being trialled that is making a difference or was it the time invested in the student and the subsequent improvement in their self-efficacy that was making the difference’. In truth, it was probably a combination but it did result in the realisation that not only did we need narrow our question but to also examine the topic through a different perspective. In this way we could ensure that continued practitioner enquiry could be designed to a point where the usability of our findings could be classed as robust. To successfully achieve this, we would need to narrow the focus whilst increasing the scope. The critical reflection that took place did so following small group discussions between all participants. In this way, an action research spiral model was favoured in order to redefine the original question with a greater definition to allow the research to gain greater depth to garner a richer understanding.

Our overall theme remains the same in that we are looking to use a Mastery approach within a model of intervention. Our previous research has led us to the theory that mastery alone is not enough and that its effects can be amplified through improving motivation and a positive mindset. In order to achieve this, we would seek to look at how we could improve motivation through improved mathematical confidence and use a problem solving approach to generate success and a more positive mindset. This transfers into a research aim:

To raise attainment in level 2 students by developing an effective mastery model of intervention which fosters a positive mindset by increasing learner confidence.

Literature Review

Learner mindset and the impact on mathematical learning

In regards to learner mindset, a review of the literature can also be triangulated with anecdotal evidence gained from discussion with the FE providers within the network, i.e. that many of the learners within FE have been taught in the lower ability sets at school which is known to have a detrimental effect on these learners (Boaler, 2013a; Higgins et al., 2015; Francis et al., 2017; Francome& Hewitt, 2019). From further discussion within the network, it is also evident that although there are many reasons, aside from ability, why students have come from a lower ability group in school, the result is inevitably the same. Students are likely to have been taught a reduced curriculum, which in turn limits the grade that they can attain in schools (Dalby, 2013; Hannula, 2002). This when coupled with the lower expectations from their teachers who too often have a fixed belief about learning and potential, automatically fixes the mindset of the students (Boaler,2010; Zevenbergen, 2005). For the student, this compounds the feeling and the experience of failure.

Teaching systems within the UK, linking results to performance tables (Perryman et al., 2011; Wilkinson & Penney, 2014) means that too often these students have been taught through a demonstration of a standard method, with tips being given to pupils emphasising how to avoid any errors (Ofsted, 2012). Prescribed strategies are taught in order to solve a task. (Sun, 2018) and students who cannot follow these often abstract algorithms come to believe that maths is simply one dimensional (ibid; Boaler, 2015)

Consequently, mistakes made are often regarded by the students, not as a learning experience but as indicators of their own low ability (Boaler, 2013a). This coupled with exam techniques relying on speed, accuracy and avoiding inaccuracies (Boaler, 2015), increases the stress and anxiety pertaining to the possibility of misinterpreting questions or miscalculating answers. In the classroom, students frightened of the ridicule and embarrassment associated with giving wrong answers, typically avoid taking risks in learning activities (Rybowiak et al., 1999; Tulis & Riemenschneider, 2008; Demirdag, 2015; Johnston-Wilder et al., 2015). Some develop what is often regarded as the ‘irrational dread of mathematics’ (Buckley & Ribory, 1982, Ashcroft & Ridley, 2005; Gresham, 2017) commonly known as maths anxiety (see for example, Ashcraft, & Kirk, 2001; Dowker et al., 2016). This often results in a mental block with anxiety impacting on both cognitive ability and working memory (Ashcraft et al., 1998 in Chinn, 2018)

Characteristically, these students develop a cultural belief that they were not born with a maths brain so will never be able to do maths (Boaler, 2016; Jonsson et al., 2012; Dweck, 2006). This socio-cultural maths anxiety (Chinn 2017) further reinforces a fixed mindset i.e. the belief that intelligence or ability is innate and unchangeable (Suh et al., 2011; Jonsson et al., 2012; Dweck, 1999, 2014). They assume that their past failures can be attributed to an unalterable ability. Along with, their unshakable belief that no matter how much effort they exert, they simply do not have the natural ability to gain their Maths GCSE (Seligman, 2007; Blackwell, Trzesniewski & Dweck, 2007), so they lose their desire to learn.

The failure cycle and the impact on learner motivation

The “condition of funding” policy, introduced in 2014 mandated that all 16-18 students who had not gained a grade 4+ (C) continue to study maths whilst still in education or training. However, given the information and literature analysed above it is unsurprising that many of these students having experienced repeated failure have low mathematical self-efficacy (Hackett and Betz, 1989; Hoffman and Schraw, 2009; Pietsch et al., 2003). They exhibit poor motivation and a lack of engagement in maths sessions. With fixed mindset, they often display an extremely negative attitude towards mathematics sitting alongside low performance and an unbalanced level of participation (Glasgow et al., 1997; Metje, Frank & Croft, 2007; Horn, 2007).

Nevertheless, a further review of current literature relating to breaking the failure cycle and student motivation indicates that if a student can be helped to believe that improvement is within their control they develop an incremental approach to learning (a growth mindset) and it follows that they start to believe that they can change the outcome (Dweck, 2000; Heine et al., 2001; Blackwell et al., 2007). A closer examination of the literature emphasises the role teachers play in helping learners to internalise their motivation (Guyan, 2013; Alt, 2015) so that the motivation becomes intrinsic (Dweck, 2000; Johnston-Wilde et al., 2015).

This is in direct contrast to the motivation that is often created in traditional maths classrooms where praise and reward is linked to getting an answer right. Where process praise is utilised, motivation becomes purely extrinsic (see for example Goldin et al., 2011). This reinforces students’ beliefs that it is only ability that can lead to achievement.

Although we know that there are many motivating factors at play in maths learning and achievement (Moore, 2001; Deci & Ryan 2008), extrinsic motivation alone can lead to surface learning with low quality outcomes (Vansteenkiste et al., 2004; Alt, 2015). Where strategies invoke personal agency (Deci & Ryan, 2002; Malmivuori, 2001, 2006; Paris & Paris, 2001) and intrinsic motivation, learner self-efficacy is improved (Pajares, 1996; Fan & Williams, 2010; Carreira, 2011) and transformative learning can take place (Imel, 1998). As self–efficacy is known to be a strong predictor of students’ achievement in mathematics (Mousoulides and Philippou, 2005; Alliman-Brissett & Turner, 2010), it must be concluded that a study of the strategies underpinning the promotion of intrinsic motivation merit further investigation.

Growth Mindset and Maths Mastery

In accordance with the literature review, any intervention planned must promote intrinsic motivation and personal agency. As many FE students have poor grades, little intrinsic motivation and a fixed mindset about maths, it is vital that planned interventions must be mastery orientated as opposed to performance orientated (Maehr & Midgley, 1991; Meece, et al., 2006). In this way, importance is placed on improvement and the learning process irrespective of the current level of the student (Meece et al., 2006) so that the students’ self-efficacy grows as they move from thinking about their ability in terms of what they have done previously to thinking about ‘am I capable of doing this?’ (Bandura, 1986; Skaalvik, 1997; Zimmerman and Cleary, 2006). As the students refine their ideas and understand that their ability is malleable, so their mindset changes from fixed to growth (Dweck, 2006).

The ideas around mastery have been interpreted and developed in different ways (see for example National Association of Mathematics Advisers (NAMA), 2015; NCETM, 2016). However, if we align the NCETM's 2016 publication The Essence of Maths Teaching for Mastery with Carol Dweck's 2008 article on Mindsets and Math/Science Achievement, the correlation is evident:

Maths Mastery (NCETM, 2016)	**A Growth Mindset Approach (Dweck, 2008)**
Maths teaching for mastery rejects the idea that a large proportion of people 'just can't do maths'.	A belief that talents can be developed and great abilities can be built over time.
All pupils are encouraged by the belief that by working hard at maths they can succeed.	A belief that effort creates success.
Making mistakes is to be seen not as a failure but as a valuable opportunity for new learning.	A belief that mistakes are an opportunity to develop.
It is recognised that practice is a vital part of learning, but the practice is intelligent practice that aims to, develop students' conceptual understanding, and encourage reasoning and mathematical thinking, as well as reinforcing their procedural fluency	Encourages thinking about learning and rejects staying in a comfort zone .

In summary, the literature reviewed suggests that teachers who reinforce the messages above throughout sessions facilitate students' resilience (Boylan et al., 2017; NCETM, 2017; Drury, 2018; McCourt, 2019). Also, if mistakes are valued as an opportunity to learn, maths becomes a positive experience (Furner & Berman, 2003; NCETM, 2017). Furthermore, teachers who embrace this model promote learner confidence by acknowledging and praising effort, improvement and challenge (Rattanetal, 2012). If mathematical discussion is skilfully used to scaffold students through problem solving, key mathematical ideas are provided for all (Nicol & Boyle, 2003; NCETM, 2014; Boyd & Ash 2018; Drury, 2018). These principles in turn ensure that all the ideology of a reduced or limiting curriculum is rejected.

Intervention strategies

In reviewing intervention strategies, it is important to specify and define what we mean by intervention. For the purpose of this study, we align with Simms et al. (2018) in defining intervention as, 'a deviation from existing teaching practice'(p8). Although we know from the Ofsted's (2009) evaluation of the National Strategy intervention programmes that there is no one effective methodology in the approach to intervention, reviewing the literature helps define the specifics of the intervention. This highlights the need to not only implement intervention for students that focuses on a mastery model and student mindset and motivation, but in addition the need to consider how intervention can:

Reinforce learning strategies and their application and make students aware of their own strategies (see for example Swanson et al., 1999; Perels et al., 2009). In this way ensuring the involvement of students in the learning process (Rogers, 2002; Watson, 2004).

Challenge students perceived ability to solve maths problems through specific problem solving intervention (Malmivuori & Pehkonen, 1997; Mason, 2003).

Review whether students' self-evaluation of their own effort and understanding in maths can also be improved through educational intervention (Mason & Scrivani, 2004)

Create a safe environment where barriers to learning, such as mathematics anxiety and stress, can be addressed and the student's experience of learning maths moves from dread and disaffection to trust and opportunity (see for example Johnson-Wilder et al., 2015; Easterbrook & Hadden, 2021). In this way behavioural interventions allow a positive effect on student attainment (Luiselli et al., 2010).

Use of manipulatives as an intervention tool

There are many definitions of the term manipulatives but for the purpose of this study, the definition by Smith (2009), who describes a manipulative as "physical objects that are used as teaching tool to engage students in hand-on learning of mathematics" (p.20), is best suited.

As a Maths team, we were seeking a solution to assist learners to move from rote-learning to gaining an understanding of underlying mathematical concepts. From reviewing the literature, it became evident that using manipulatives across the curriculum would assist students to internalise abstract concepts by exploring physical representations in a variety of ways (Cropley, 2001; Allen, 2007; Merttens, 2012; Larbi & Mavis, 2016). Thus moving the students to attach these concepts to real world concrete examples (Charbonneau et al., 2013).

Teacher intervention through CPD

From the literature review, we can concur with the view that the main purpose of any CPD is to ensure that staff can change, grow and develop (Basinger, 2003). Also noteworthy is Borko's (2004) premise that as teachers' attitudes, confidence and beliefs change following CPD, this is reflected in a similar change in the students that they teach.

To look at what would be needed and how we could begin this change, we reviewed the literature pertaining to CPD associated with teacher mindset and the mastery model.

Firstly, the literature reflected both the teacher and management views that the CPD had to have minimal disruption on classroom learning (See for example, Conway & Sloane, 2005; Johnston-Wilder, 2016). It also needed to appeal to both the expert and the novice. Finally, the literature suggests that teacher CPD yields the right results when a multi-faceted approach involving differing alternative approaches is taken (ibid.).

Conclusion

In comparing the ideologies behind a growth mindset (for both the students and the teachers) with the key principles of mastery goals and a mastery curriculum, we must

conclude with Pearson's 2018 statement that the two concepts go hand in hand (Pearson, 2018).

The limitations of this literature review concerning the analysis of the curriculum and the lesson structure pertaining to Further Education are recognised. This is largely due to the lack of published research on how these principles are translated into a sector where time is limited often to below three hours per week and students may have already been taught by rote and have deeply ingrained misconceptions. However, the analysis of the literature outlining the principles behind the ideologies of a growth mindset linking to a mastery model of intervention provides a sound basis to shape, add value to and further endorse the research questions and the associated outcomes.

Methods – What methods did we use to gather our information?

Research methodology

The analysis of the literature review, along with evaluation of 19-20 first Action Research (AR) cycle allowed the refining of the research question and a focus emerged allowing for the research design to be shaped.

With consideration to the practicalities and workings of FE, the AR also incorporated some of the design elements of an ethnographic research project in that the research was conducted largely from the teachers practising within the field (Hamersley and Atkinson, 2007). The marrying of AR and ethnographic research is common amongst educationalists as the ethnographical element directs the process whilst the AR connects the research back to the study's plans and activities.

As we wished to have a deeper breadth and depth of understanding and corroboration whilst combining the use of both qualitative and quantitative perspectives to maximise the strengths and minimise the weaknesses of each type of data (Johnson et al., 2007; NIH Office of Behavioural and Social Sciences, 2018), we concluded that we would take a mixed method approach (See table 1). There was, however, an acknowledgment of the importance of maintaining validity (Johnson & Christensen 2017) and so it was paramount that the data collection design be mindful of the need for multiple triangulation opportunities and quality of data (ibid.).

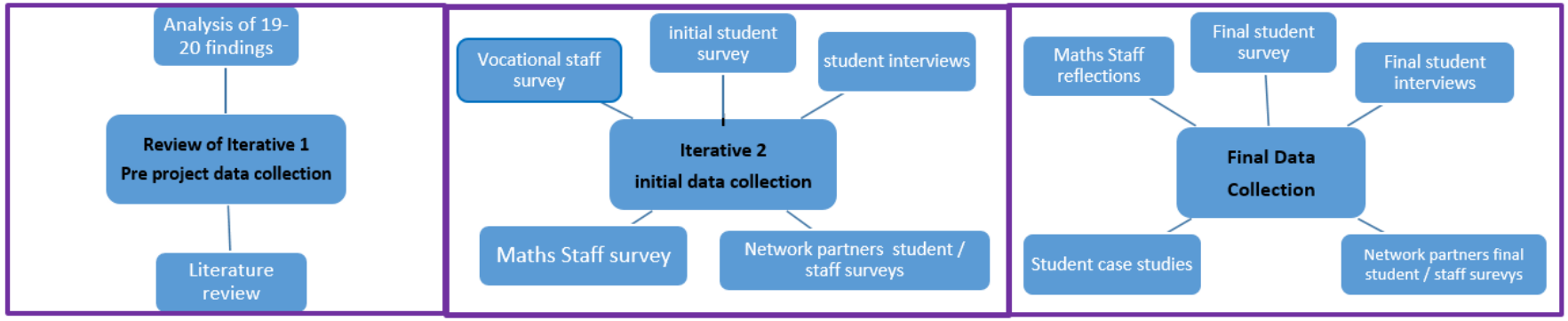
Ethical Considerations

Taking note of the BERA Ethical Guidelines (2004), all participants were fully appraised of the research project, the beneficence (Murphy & Dingwall, 2001) and the use any outcomes would be put to. An awareness of the potential conflict of a dual role as both a teacher and a researcher were considered but all students will be assured from the outset that their learning experience and issues surrounding confidentiality will not be impeded by this study. In addition, informed consent was sought and all students were reminded that their participation was voluntary with right to withdraw at any time (BERA, 2004). Furthermore, students were assured that they would not be identifiable, as individuals, from the final report (Flick, 2006). Finally, all interested parties were assured of the mechanisms that were used for processing and storing the research data in line with Data Protection Act 1998 (DPA 1998) and any concerns with regard to GDPR will be discussed as appropriate.

Data collection methods

The data collection methods can be best summarised through diagram 1.

Diagram1: Illustration of Qualitative and Quantitative data collection methods



Data Analysis

Coding took place through a methodical two-phase inductive coding approach to allow for both thematic coding (Strauss & Cobin, 1998) and discourse analysis (Coyle, 1995).

Covid Impact

Although Covid meant that learners needed to swiftly move to online learning, we were still able to continue with our original research aim. We did however have to limit the use of physical manipulatives so selected classes who remained learning in college at all times. We also have to change our data collection tool to online questionnaire surveys to enable the reach needed.

Results and Discussion

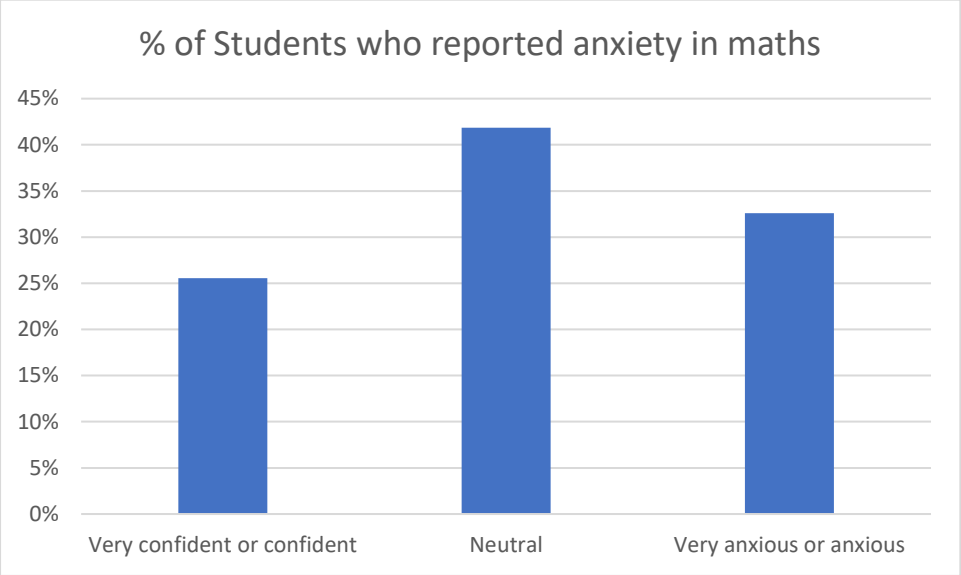
Survey & Interview Results

Initial Results

Initial student questionnaires were sent out to Tameside maths students and to our network partners' students. There were 400 responses to the survey and we randomly selected circa 100 of our own students to ask more in-depth questions.

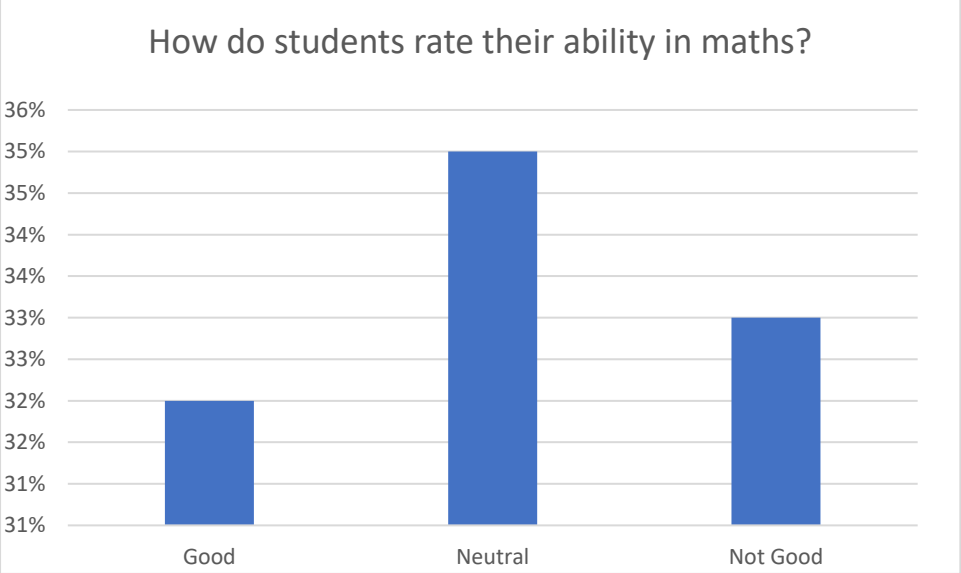
Our main findings from this survey are as follows:

Maths Anxiety



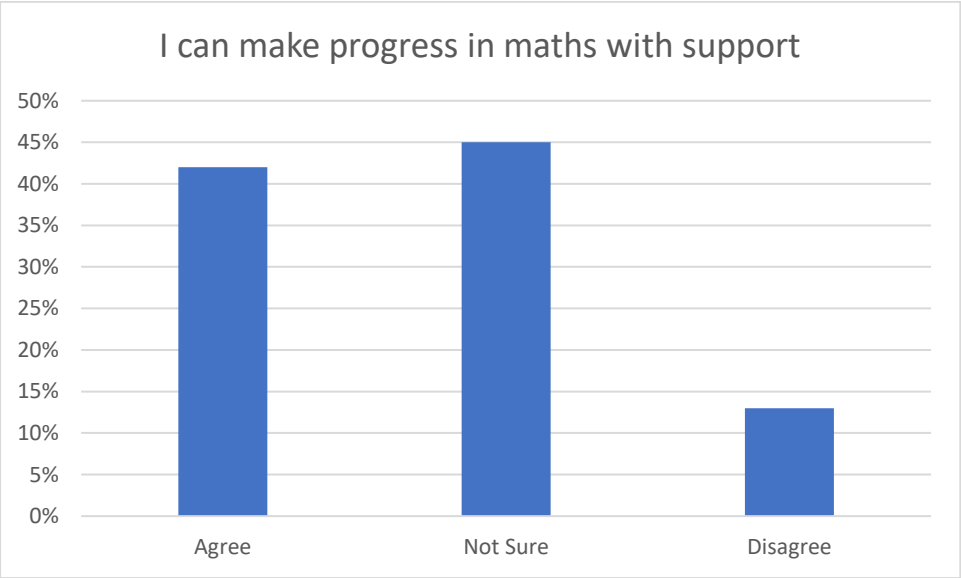
33% students (130) surveyed said that maths made them feel anxious. 42% were neutral and 26% stated that they felt confident about maths.

Ability in Maths



33% of the students rated their ability in maths as not good, 35% as neutral and 32% as good. The split is roughly equal.

Progress in Maths

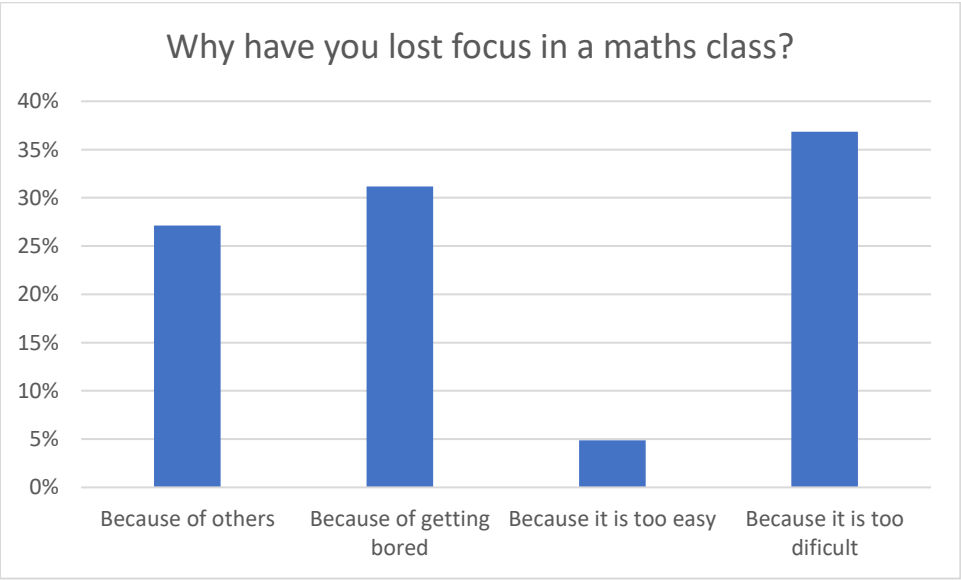


42% of the students felt that with support they could make progress, 45% were not sure and 13% felt that they would not make progress

A significant number of students (42%) felt that they could make progress in maths with support and only 13% felt that they would not.

What was their previous classroom experience in maths like?

Students reported that they had lost focus in a previous maths class because it was too hard for them (99) and others reported that they had become bored (77) in previous classes. 67 students reported that they had struggled to concentrate because of others in the class.



27% of the students had lost focus because of others in the class, 31% had become bored, 37% had found the maths too difficult to follow and 5% reported that it was too easy

It was not clear at this stage why students had “been bored” in class but this would be followed up in more in depth interviews. What is clear is that degree of difficulty and peer influence has played a significant part in student perceptions of maths previously.

Why do students not make progress?

Lack of confidence and revision were the two main things mentioned by students as to why they had not made progress. Despite peer interactions being mentioned previously as a reason as to why students had lost focus it is apparent here that that students do not fall out with others over it.

Lack of confidence (26%) and lack of revision (28%) were cited as being the two most significant reasons as to why students do not make progress

When we followed up the initial survey findings with randomly selected students who were then spoken to in some depth, two points stood out.

Previously set targets were considered by several students to have been so vague that the students simply were not sure what they had to do

When asked what would have been useful for them to have done, a significant number mentioned that being shown how to break down questions was particularly important to them.

We also sent a short survey to our vocational colleagues where we found that 33% had not come across the terms fixed/growth mindset and had requested additional information

From these results we determined that we needed to:

Address the anxiety issues in our students

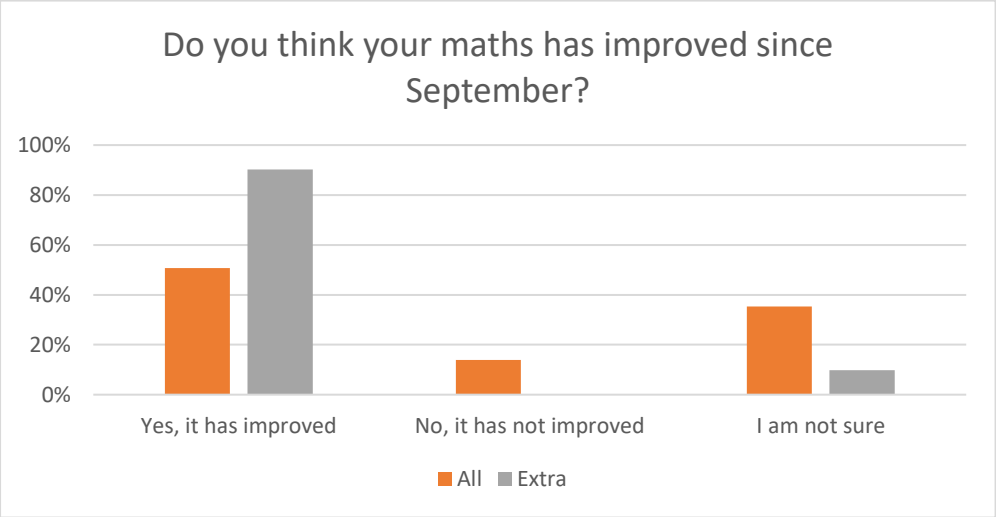
Work with students to provide individual support in maths that worked on confidence, was meaningful revision and had targets that were specific for the students to work towards

Work with our vocational colleagues as well as maths colleagues to find meaningful mindset CPD

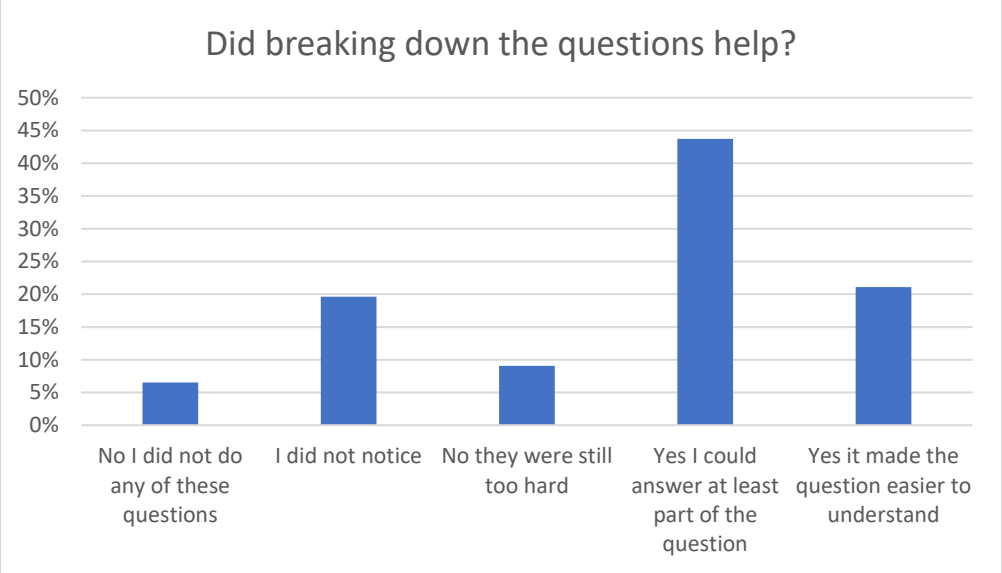
Final Results

We split our follow up research into 2 main parts, intervention in and out of the classroom and mindset both student and staff orientated. The intervention out of the classroom focused on small group additional maths lessons for any learner who wanted to participate, this was approximately 50 learners. The in-class intervention focused on the use of physical manipulatives with two classes of entry level maths students, which was approximately 30 learners. The mindset intervention focused on techniques to reduce maths anxiety, especially before assessments, this was for all students at the college so was aimed at approximately 1000 learners. The staff orientated mindset intervention focused on mindset CPD for our maths team, vocational staff and our network partners, this was approximately 65 members of staff. After implementing these changes, we then regathered evidence from surveys, student interviews and staff discussions.

Intervention – Extra Sessions



51% of all students surveyed said that their maths had improved over the year, 35% were unsure and 14% said no improvement. With extra intervention students this became 90% who were sure of improvement and 10% who were



When questions were broken down, 44% of students surveyed said that this helped them to answer at least a part of the question and a further 21% said that it made the whole question easier to understand

When asked what helped their improvement, the following points were made by our students who participated in the extra intervention sessions:

The ability to practice their skills outside of the classroom

The opportunity to get more explanation around a question (breaking the question down) without disruption.

The opportunity to concentrate more on the parts of maths that you struggle with without the distractions of a main class

Extra Intervention - Student Comments

These comments were typical of the responses we got from the students whom we asked for their views on what had helped them to improve.

for my review of the open book quiz i chose questions 13 and 14 on the pie charts, as normally struggle with pie charts but i did will on them as i have practiced in intervention
Student K (Extra intervention student, 1st year college)
(extra intervention) helps because I am not in full class and gets extra explanation and fewer disruptions
Student E (Extra intervention student – English not first language)
It does because there are not other people to disturb me - can concentrate more
Student EA (Extra intervention student – Final Year of College, needs a G4 for University)

It is worth noting that students have mentioned the lack of distraction as being valuable in extra intervention sessions and this was something that had been noted in the initial survey results.

We went out to all students to ask if they would be interested in having dedicated tutorial time for maths next year and 39% said that they would.

Intervention – Manipulatives

We were unable to use manipulatives in all the classes that we were originally planning because of Covid and so concentrated on using manipulatives in two lower level maths classes.

We followed the literature here in using physical concrete objects that the students could touch, move around and re-group so that they could see and understand the problems they were trying to solve.

The use of manipulatives in mathematics instruction has been cited as a strategy to allow students to draw on their practical knowledge. This line of reasoning suggests that concrete objects that resemble everyday items should assist students in making connections between abstract mathematical concepts and the real world (Charbonneau et al., 2013)

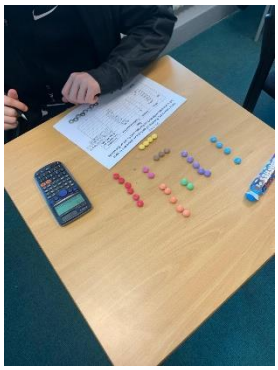
For the first class, we used snap cubes specifically to work on multiplication/division where the students could work on investigating different combinations of cubes so that the students could gain a better understanding of multiplication.

For student M who has literacy issues this meant that “I can see this problem and I don’t have to worry about reading it”

In the second class, Smarties were used to help the students explore what fractions “looked like”. It was observed that students were working independently and were more willing to try different combinations even if they were getting things wrong.

Student vignette:

I feel like the smarties helped me with figuring out fractions. I would look at the fractions and numbers and get the amount of smarties that I needed. I feel like it is easier with a physical object, when we are given work with no physical equipment, like blocks or counters, it is harder.



From our final survey, we found that 62% of the students said that they preferred to learn maths in the classroom with access to the teacher and physical resources. It could of course be argued that the need to be in a classroom is a response to the impact of COVID but as the research says, sometimes a physical presence is required.

It is argued that technology cannot replace the physical presence of learning such as spontaneous discussion (Chen & Lambert, 2018).

Intervention – Short Term Target Setting

The literature tells us that targets are useful for both providing evidence/guidance as well as encouraging students to take an active part in the lesson.

By establishing clear learning targets… teachers can collect more accurate evidence of student learning, provide students with more effective guidance and feedback, and help students take ownership of their learning (Konrad et al.,2014)

In order to assess the impact of targets on students, we selected several small groups of students who were given specific targets related to a specific piece of maths as well as a more general target relating to why they had answered a particular maths question well (so that they could apply the same technique in the future).

The majority of students completed the maths related targets and this was particularly successful in the intervention students who were doing additional intervention out of class. However, it may be that these students were already pre-disposed to find targets useful in that they had already elected to do extra maths.

The target related to “what went well in a question” was more challenging for students and answers had to be found from the student verbally rather than in written form – they could explain what they had done when asked but they needed the question to be broken down so that they could answer it a bit at a time.

Student Comments

These comments were typical of the responses we got from the students whom we asked for their views on target setting.

“something to aim for” *“number of targets should relate to number of questions you got wrong”*
Student A (Extra Intervention – 3rd year of college)
“They (targets) should tell you what you need to work on”
Student E (Extra Intervention – 1st year of college)

Intervention – Mindset

Student Impact

33% of students initially surveyed had reported maths anxiety. Within Tameside College and following staff CPD we introduced “The tiger in the room” metaphor to explain to students why they felt anxious in the classroom.

We explained that if a tiger came into the classroom, then students would feel understandably anxious and concerned. They would be unable to focus on what they were doing. Even without the tiger, students feel anxious and unable to focus so we must look at ways to reduce this anxiety.

We implemented various strategies to keep students calm and focussed including:

- deep breathing,
- listening to the sounds of the classroom,
- doing a dot to dot exercise that spells out a supportive phrase
- and chewing sweets

When students were asked again at the end of the year, 27% of students surveyed said that they felt anxious in maths, a small but significant reduction.

Pleasingly, 51% of the students surveyed said that they would be interested in developing their positive mindset and problem solving approaches in the future which is something that we can take further next year.

Staff Impact

We concentrated this year on making Mindset CPD available to our own maths staff, our network partners and our vocational colleagues. We had used the concept of reflective journals for our maths staff in order to record their thoughts throughout the year. This has given them the opportunity to think about their teaching and their own mindset. By investing in the mindset CPD staff have felt energised and valued.

The training has allowed teachers valuable thinking time in which to reflect on their own mindset, how that impacts on the students and what changes they could make.

Conclusions and Recommendations

Conclusions

To promote creative approaches to teaching and learning effectively, students should be encouraged to learn independently, whilst being given the opportunity to work with a variety of materials under different conditions (Cropley, A. J. 2001, p.138). For this reason, both physical resources and virtual manipulatives (for online learning if there are any future disruptions to in-class teaching) need to be made available to meet the needs of all learners. The use of manipulatives in mathematics instruction has been cited as a strategy to allow students to draw on their practical knowledge, suggesting that concrete objects that resemble everyday items should assist students in making connections between abstract mathematical concepts and the real world (Carbonneau et al., 2013). Unfortunately, as a result of the pandemic, manipulatives could only be used with a restricted number of classes for this academic year.

As many FE students have poor grades, little intrinsic motivation and a fixed mindset about maths, it is vital that planned interventions must be mastery orientated as opposed to performance orientated (Maehr & Midgley, 1991; Meece, et al., 2006). Provisional results show that student mastery intervention works outside of the classroom, as a significant proportion of our additional intervention students' grades improved this year. However, additional intervention sessions are not a sustainable strategy for student progression once the CfEM project comes to an end.

If students are helped to believe that breaking their cycle of failure is within their control, they may start to believe that they have the ability to change the outcome, resulting in them shifting to being intrinsically motivated (Dweck, C. S. 1999). Student mindset intervention works in the classroom through the promotion of a positive teaching environment. Although, our students only attend maths sessions once a week, so a growth mindset may not be consistently promoted to learners during their main course classes. By establishing clear learning targets, teachers can collect more accurate evidence of student learning, provide students with more effective guidance and feedback, and help students take ownership of their learning (Konrad et al., 2014). Therefore, more individual and directed target setting helps to promote a growth mindset.

As teachers are the most important asset in a school or college, they should be professionally developed in a way that motivates, interests and inspires them. They should be given a rich and varied ongoing programme of activities that they can engage with, which will support them to reflect upon and develop their own practice (Allison & Beere, 2014). Staff CPD in the form of mindset intervention works because it allows staff dedicated thinking time as well as the opportunity to try fresh approaches and ideas. Teachers who embrace a growth mindset model promote learner confidence by acknowledging and praising effort, improvement, and challenge (Rattanetal, 2012). Thus, it would be useful for growth mindset strategies to be shared amongst not only maths teachers, but all teachers within FE.

Final Conclusions

Did we raise attainment in level 2 students by developing an effective mastery model of intervention which fosters a positive mind-set by increasing learner confidence?

Attainment this year will be difficult to judge accurately because of the impact of both covid and the assessment process

Provisional trend data indicates a significant increase in grade improvement

We are now in a position to refine our mastery model of intervention based on our knowledge of what works both in and out of the classroom

We are now able to recommend the mindset strategies that should go forward to be included in the induction of all maths students as well the college induction

Recommendations

As colleges we need to:

- help students make the connection between maths ability, maths confidence and employment by making intervention available to all students by bringing it into the classroom as well as having stand-alone intervention sessions
- enable students and staff to realise that a Grade 4 is not an instant “Golden Ticket” but rather an end goal that may take more than 1 year to reach by adopting a whole college approach and making every teacher an intervention teacher thus ensuring continuing sustainability
- adapt our teaching and learning framework (and Whole College Approach) to make gaining maths confidence through a positive mind set approach an integral part of college enrolment, induction and tutorials and will become a focal point of observations within the maths department
- build on staff intervention by working with our progress tutors, main course teachers and network partners to incorporate mindset training into every aspect of our student interactions

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Appendices

Appendix 1 – Initial Survey Questions - Students

(amalgamation of questions used internally and with our partners)

Questions were answered anonymously

Q1	On a scale of 1 – 5 where 1 is not good and 5 is good, how would you rate your ability in maths?
Q2	On a scale of 1 - 5 where 1 is very anxious and 5 is very confident, how do you feel about maths?
Q3	When you have to do a maths question that you find hard, Do you Worry that you cannot do it Have a go Guess an answer Try and break it down Leave it
Q4	What do you think of the statement “I can make progress in maths with support”? Do you agree, you are not sure or you disagree
Q5	Why have you lost focus in a maths class? Is it because a) of others in the class b) of boredom c) it was too easy d) it was too difficult
Q6	What has stopped you making progress previously? Is it because a) you did not get on with others b) lack of confidence c) not doing enough revision d) lack of attendance e) combination of above f) no response
Q7	What are your aspirations after leaving college? Write a short response
Q8	How will achieving a GCSE in maths help? Write a short response
Q9	How can college help you to achieve? Write a short response
Q10	On a scale of 1 - 5 where 1 is not at all and 5 is very useful, Do you feel maths will help you in your chosen career?
Q11	How do you feel if you get a question correct? Good Ok Not bothered
Q12	Will maths help you later in life? Yes, because it helps me to problem solve No, because someone else will do it

	Yes, because I think I will need it No, because I have not used it yet
Q13	What do you think of Microsoft Teams? a) good b) neutral c) Not good
Q14	Do you know how to access your maths work online? Yes No
Q15	Which technological devices do you have access to? Laptop Phone Tablet None
Q16	Have you used other online platforms previously? Used other platforms Not used other platforms

Appendix 2 – Final Survey Questions - Students

(amalgamation of questions used internally and with our partners)

Questions were answered anonymously

Q1	On a scale of 1 - 5 where 1 is very anxious and 5 is very confident, how do you feel about maths?
Q2	Do you think your maths has improved since September? Yes No Not sure
Q3	Did you find breaking questions down helped? No I did not do any I did not notice No they were still too hard Yes, I could answer at least a part of the question Yes, it made the question easier to understand
Q4	Do you prefer to learn maths online, in the classroom or a mixture? Online only Classroom only Mixture
Q5	If you are continuing with maths next year, would you prefer some dedicated tutorial time so that you could go through work in a smaller group?

	yes no not sure depends on timetable
Q6	Should targets be set after each assessment? Yes No Not sure
Q7	Should students be involved in setting their own targets? Yes No Not sure
Q8	Would you like to learn more about how you could develop a positive attitude to maths and problem solving? Yes No Not sure
Q9	How do you feel about working online? I have found it better as I can work when I want I like watching videos and then having a go I feel that I can make progress online I am happy to work on my own I have issues at home that make it difficult to work online I feel Covid has increased my family responsibilities
Q10	When you get feedback on a question, do you? a) Read it carefully b) Skim through it c) Ignore it
Q11	Is it useful if your feedback, mentions the grade you are working at even if this is not yet a Grade 4/5? Yes No
Q12	Do you prefer verbal or written feedback? Verbal Written Both

Appendix 3 – Follow up questions following initial survey

(Questions used internally with a small sample of students)

Questions were collated anonymously. Questions were same as survey but were open ended and Q11/12 follow up questions

Q1	On a scale of 1 – 5 where 1 is not good and 5 is good, how would you rate your ability in maths?
Q2	On a scale of 1 - 5 where 1 is very anxious and 5 is very confident, how do you feel about maths?
Q3	When you have to do a maths question that you find hard, what do you do?
Q4	What do you think of the statement “I can make progress in maths with support”? Do you agree, you are not sure or you disagree
Q5	Why have you lost focus in a maths class?
Q6	What has stopped you making progress previously?
Q7	What are your aspirations after leaving college?
Q8	How will achieving a GCSE in maths help?
Q9	How can college help you to achieve?
Q10	Do you feel maths will help you in your chosen career?
Q11	Have you found targets useful for you in previous maths classes? Can you tell me why they were or were not?
Q12	What was the most useful bit of help that you got in a maths class?

Appendix 4 – Interview Questions

(Questions used internally with a small sample of students)

Questions were collated anonymously.

Target Questions

On a scale of 1-10 – Do you find targets that you can work to useful?

(1 least useful – 10 most useful)

1 2 3 4 5 6 7 8 9 10

Does a target give you something to work towards?

Yes

Don’t think about them

You don’t see why they are important

Other

Should you set your own targets?

Has a target ever helped you achieve a goal? If so describe briefly

Do you think you should have targets set after each lesson or after each assessment? If so how many?

Appendix 5 – Network Partner Questions

Q1) How did your college deliver maths Sept 2020 – Dec 2020?

Q2) What online platform did you use to deliver?

Q3) What was the main technological challenge that you faced and how did you resolve this?

Q4) Do most of your students have access to technology and internet?

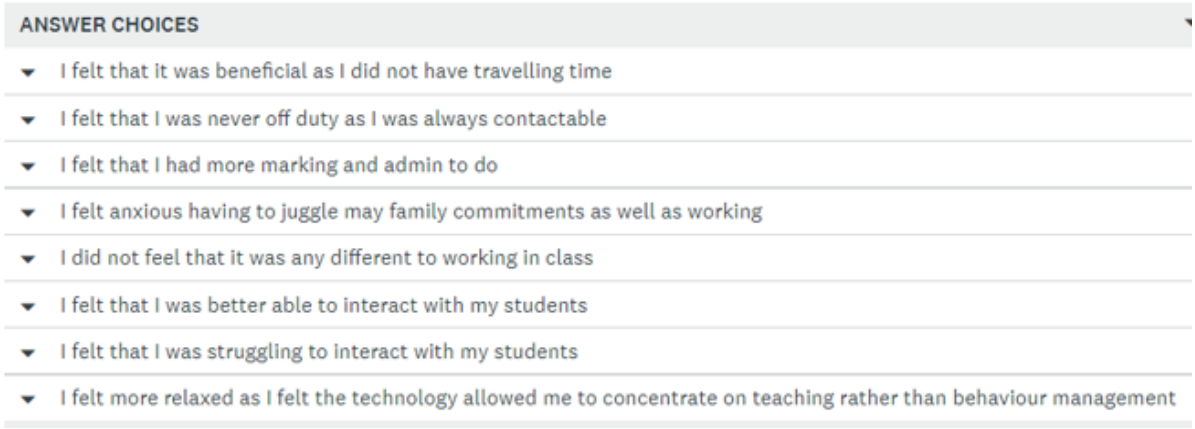
Q5) Are students generally able to access live lessons?

Q6) During the period of Jan 2021- Feb half term did all of your teachers work from home?

Q7) What do you feel have been the main impacts on you as a teacher having to teach through your technological medium? (Tick all that apply)

ANSWER CHOICES
I felt overwhelmed trying to learn new things
I felt that that coping with the technology generated more work
I felt okay with it generally
I felt anxious about using the technology
I felt that I taught more effectively using technology

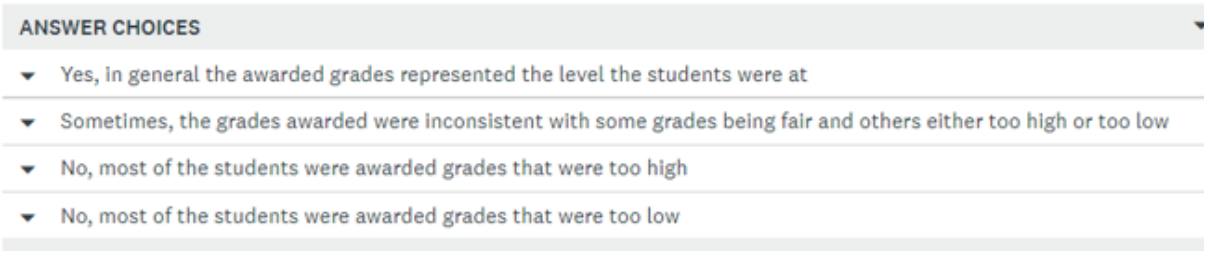
Q8) What do you think have been the main impacts on your home/family life because you were working from home? (Tick all that apply)



ANSWER CHOICES
I felt that it was beneficial as I did not have travelling time
I felt that I was never off duty as I was always contactable
I felt that I had more marking and admin to do
I felt anxious having to juggle may family commitments as well as working
I did not feel that it was any different to working in class
I felt that I was better able to interact with my students
I felt that I was struggling to interact with my students
I felt more relaxed as I felt the technology allowed me to concentrate on teaching rather than behaviour management

Q9) Would you be willing to take part in a short anonymous interview where the impact on you as a teacher could be explored more fully?

Q10) Many students started this academic year with teacher awarded grades. In your opinion did these grades generally reflect fairly the level students were actually at?



ANSWER CHOICES
Yes, in general the awarded grades represented the level the students were at
Sometimes, the grades awarded were inconsistent with some grades being fair and others either too high or too low
No, most of the students were awarded grades that were too high
No, most of the students were awarded grades that were too low

Q11) In your opinion, has working remotely impacted upon student confidence in maths?

Appendix 6 - Curriculum Area responses

Q1 Did you enjoy maths at school?

ANSWER CHOICES
Yes
No

Q2 How would you rate your mathematical confidence?

ANSWER CHOICES
Very confident
Confident
Neutral
Anxious
Very anxious

Q3 Do you think you would benefit from extra support in maths to help you support your students?

ANSWER CHOICES
Yes
No

Q4 What is a positive experience you can remember you had in a maths classroom?

Q5 What is a negative experience you can remember you had in a maths classroom?

Q6 Do you think maths is important in your curriculum area?

ANSWER CHOICES
Yes
No

Q7 What is your curriculum area?

Appendix 7 – Interview Questions

(Questions used internally with a small sample of students)

Questions were collated anonymously.

Feedback Questions

When you get feedback on a question you got wrong, do you?

Read it carefully

Skim through it

Ignore it

Other

On a scale of 1-10 – Do you find feedback useful?

(1 least useful – 10 most useful)

1 2 3 4 5 6 7 8 9 10

Is it useful if your feedback mentions the grade you are working at even if this is not yet a Grade 4/5?

Which do you prefer verbal or written feedback?

What is the best piece of feedback you ever got in maths and why?