CENTRES FOR EXCELLENCE IN MATHS

NSCG NEWCASTLE AND STAFFORD COLLEGES GROUP

To explore the effectiveness of a mastery model in an FE setting and the role of technology in supporting learning

Theme: Responsive Teaching

Researchers

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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

Executive Summary

Our Action Research project focused on delivering resit GCSE maths to 16-19 year olds in Further Education (FE) settings. As a group of FE colleges in the Northwest Midlands of England we focused on using technology to supplement a mastery based delivery within an FE setting. Our goal was to evaluate impact on learners' engagement and motivation and ultimately how this affects their progress and achievement. We considered other factors such as students' confidence, flipped learning and mathematical anxiety. These ideas help inform and mould our research direction and themes. Throughout each cycle of our research, we ensured that everyone had a voice; we collected learner views on our intervention and the impact it had on both their mind-set and our delivery of this intervention. Over the course of the project, we surveyed c150 students to delve deeper into the effectiveness of our intervention. As we have 4 different settings involved with 5 teachers completing the action research, we collected a comprehensive amount of information and data surrounding all aspects of our research. South Staffordshire College was a later addition to group;they joined after we completed the intervention but have been quintessential for discussion and analysis results. In summary, the majority of students stated that our intervention has helped improve their confidence with GCSE Maths and in turn students have made considerable progress during this time. Many enjoyed the videos, which were presented in a TikTok style that was concise, succinct and explained the question in manageable sections. The large majority of, students were very positive towards the created videos, but a small number felt they were too quick. The overall outcome was that incorporating this technology mastery approach within an FE GCSE Maths provision can have numerous advantages, but a careful balance must be found to incorporate a model which allows enough flexibility to adapt to meet the needs of each learner.

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Background

Introduction

Newcastle and Stafford Colleges Group (NSCG) is a General Further Education (GFE) College based in Staffordshire. NSCG is a CfEM Centre which has facilitated an Action Research Group in the academic year 2021/22. The Network Partners who have collaborated on the Action Research along with teachers from both Newcastle and Stafford Campuses are three GFE's from the region: Buxton and Leek College, Telford College and South Staffordshire College. The researchers are five teachers in total, with two teachers from NSCG College.

The size of the group has allowed for a wide-ranging scope of learners and teachers from differing backgrounds to be surveyed, and it created a varied, engaged and supportive discussion group at the Microsoft Teams fortnightly meetings.

Each teacher has participated in the group with the common aim of finding ways to better support their learners and finding approaches to enhance their teaching delivery, with a challenging subject that is not chosen by the learner.

Colleges and Learner Cohort Make-up

Newcastle and Stafford Colleges Group is a leading General Further Education College. The college provides a wide range of academic, vocational and apprenticeship qualifications from entry to degree level, along with support services. The college was rated as "Outstanding" by Ofsted following a full inspection in November 2019. The college has 4719 full time learners, including 966 maths resit learners (872 GCSE, 94 Functional Skills).

Buxton and Leek College was formed in 2013 by the University of Derby combining the FE operations of Buxton College and Leek College and is currently rated as "Good" by Ofsted following an inspection in March 2019. The Buxton campus is based at the famous Devonshire Dome in this Peak District Spa town, and the Leek campus is based on Stockwell Street which can be traced back to the original College of Art founded in 1868. The college offers academic and vocational courses, including apprenticeships, NVQs, BTECs, GCSEs, and Access courses, as well as a range of leisure courses. Shortlisted for the TES Award for GCSE Resit Provision in 2020, they went on to win the Award in 2021. The college has 710 full time learners with 355 maths resit learners (86 GCSE, 269 Functional Skills).

Telford College was formed in 2017 from the merger of Telford College of Arts and Technology and New College Telford. It is a General Further Education and A-Level provider of medium size delivering the spectrum of technical, vocational and academic skills and subjects, including Apprenticeships. The college delivers maths to just under 1000 learners with around 250 students studying GCSE maths and 400 students studying Functional Skills maths as part of a wider, full-time study programme. Telford College has recently been graded as 'Good' by Ofsted, following full inspection in February 2022 and is proud to be named among the top 25% of providers nationally.

South Staffordshire College was formed in 2009 after the merger of 3 colleges and now operates over five sites. The college offers a range of further education courses including NVQs, apprenticeships and access courses. The college has 2502 full time learners, with 976 maths resit learners (826 GCSE, 150 Functional Skills). South Staffordshire College recently rated as "Good" by Ofsted, following an inspection in November 2021.

Research Focus and Aims

This Action Research report focuses on the impact of using a mastery-based approach while using technology to supplement this learning.

Many maths GCSE resit students arrive at college classing themselves as a 'failure'; having obtained a grade 3 or below in GCSE, they can lack confidence, have behavioural issues and some have undiagnosed extra learning needs. It is also worth noting that these students have come through almost 2 years of Covid-19 lockdowns and as a result many were lacking in key skills as well as motivation.

We wanted to investigate how mastery models have been approached in our FE resit GCSE Maths settings, to discuss their structures and how they have impacted the learners. To do this we drew from key findings in previous Action Research projects seeking both student and staff perspectives to create a model that would effectively incorporate technology. The educational sector has faced many challenges in recent years, and we aspire that our research will provide a successful model that FE providers could use as an effective teaching and learning strategy. The NSCG Action Research group's (ARG) aims and objectives reflect the aspects that we will be focusing on:

- To understand current mastery & related teaching approaches models and how we could link those to GCSE Maths resit students
- To assess and explain ways in which a technological based mastery approach supports learning relating to progress and attainment.
- To analyse the student—teacher relationships that are fostered as a result of a technology-based mastery approach model.
- To examine the viability of implementing a technological based mastery approach for deeper understanding and decide the demand of CPD needed if rolled out
- To share results and, if possible effective approaches, with GCSE maths resit teachers locally and nationally.

Mastery Model and Topics Selection

In order to construct our mastery model to effectively meet the needs of our students we used extensive exam analysis. All the exam series since the introduction of the 9 -1 GCSE were collated. The question frequency and the average score for each question were analysed. We focused specifically on the topics that a typical grade 4 student could competently complete, compared to the topics that the typical grade 3 student could competently complete. When we use the word "typical grade 4" this is the mean average score on that skill for a student that achieved a grade 4. We then looked at the topics where there was a considerable gap between the typical grade 3 and the typical grade 4 student. The question frequency was also considered in order to pick these topics. We used this analysis to agree upon our eight areas of the curriculum which would form our intervention. The topics are shown below:

- Percentages
- Factors, Multiples and Primes
- Area
- Solving Linear Equations
- Translate situations to algebraic notations
- Use Compound Units
- Direct and Indirect Proportion
- Ratio

We agreed that we would include the topics in lessons over the course of an eight week period and include an exam question for each area, each week. We would use underpinning mastery skills to build students' knowledge over the weeks along with using TikTok inspired videos that would engage and encourage the students.

Technology

So why TikTok? The Guardian newspaper (2021) suggested from recent studies that even the mere *presence* of a smartphone reduces attention spans and throws off concentration on the task, let alone students surreptitiously trying to use their phones in class. So, the ability to embrace an opportunity to use smartphones to do maths could not be missed. Some of the ARG members had explored TikTok previously with regards to maths tips and tricks and saw interesting ideas such as an 11 second video of 'How to multiply - Fast!' or 50 seconds on 'How to use the table function on your scientific calculator'. We consulted the students to see whether they used the platform intended and 100% of the students suggested to the affirmative. We sought to use this technology and combine it with a mastery approach. So, we created a TikTok style video for every single question that was included in our intervention. Due to any possible issues involving safeguarding we felt as a group that we would not share directly on the TikTok platform. So, to share the videos with the students we created a weekly Desmos activity that contained the videos along with a sliding scale to rate confidence and an input box if they wished to express their opinions.

Mastery in Post 16 Maths GCSE Resit

The first aspect the group of teacher-researchers considered was how they define what 'Mastery in FE GCSE Maths looks like'. Mastery has been shown to be an effective strategy in both a primary and secondary setting, but there is little research at its efficacy within a FE GCSE Maths setting. We drew heavily from past Action Research to create an approach that would aim to meet the needs of students to ensure students develop a deep, strong, long-term and resilient understanding of mathematics. We further wished to widen the scale, what are the learners' experiences and how does this compare to the teacher's perspective? How can technology impact this? Can it break down any barriers towards mathematics? Is it suitable for all learners? Also, will it help to engage students that are particularly difficult to engage?

Literature Review

Mathematics is one of the most essential subjects that we are taught throughout our lifetime. Its importance at every educational level cannot be overstated. At the Further Education level, GCSE resit learners often have big skills gaps and are poor at retaining mathematical knowledge.

Mastery in Mathematics can be described as a collection of teaching and learning strategies that are designed so students will achieve an elevated level of competency in a given area if they are given enough time (Block & Anderson, 1975). The ideology of this pedagogical approach is simply; if each student is given ideal quality instruction and as much time as they need, then this student can go on to attain mastery in said subject (Filgona , Filgona & Sababa, 2017).

To achieve this goal, according to theories of mastery, learning should be organised into stages. In order to move to the next stage a student must master the prerequisite step. This type of learning engages the student in various instructional approaches, learning levels and multiple cognitive learning styles.

At its heart, mastery is based on the tenets that all students can become proficient and succeed if they are taught at a level suitable to their competency. The student is gradually reassured to progress at a rate of their ability through a series of distinct components of learning. These components of learning are of course predetermined and break the subject into a series of objectives or skills. Students persist with a cycle of learning until mastery is achieved. The skill must be demonstrated, usually via an assessment before progressing to the next skill (Bloom, 1968). The loop must be closed, and student feedback must seek to point out and attempt to correct the problem the student has with that particular skill (Guskey, 2005).

Improving the learners' retention of mathematical concepts is an intricate and entwined issue for both lecturers and students. Anecdotally we see that students perform well in classrooms but struggle to transfer this to assessments and their GCSE exams. Gains (2001) suggests retention is vital for this to be successful, if students cannot competently recall previous knowledge, then time is spent re-teaching past material. Filgona, Filgona and Sababa (2017) argue that the student successfully completing assessments designed to gauge their progression can demonstrate retention. It is argued by May (2013) that students recall of taught material rests upon the type of teaching. With teaching ideas that involve deep instruction, (to achieve mastery), they seek to strengthen the bonds between new and old information and allow a learner to progress at a much faster rate and furthermore increase their ability to retain said information. Additionally, Wentling (1973) whose study compared mastery style delivery versus other instructions found that those who followed this approach retained more information in both the short and long term.

However, more often than not, higher-level maths is taught by giving formulae and memorising procedures. By learning procedure, students are not necessarily developing a mastery of the topic.

By applying Bruner's Theory (1966), students are encouraged first to tackle the subject in an enactive way - using materials, or manipulatives to be able to understand. Then this develops in constructing mental imagery or representations but without using physical objects. Finally, at the symbolic level, the student can solve the problem without either of these being necessary (Drummond, 2019). In essence, if lower ordered cognitive ideas are not mastered, this can then discourage the student to the higher ordered cognitive skill.

As found by Shanbhag (2002), the use of mastery learning produced a positive effect on both learner retention and acquirement of new knowledge when investigating the concrete to abstract learning spectrum. The findings of Shanbhag's studies are consistent with those of Ezinwanyi (2013), Hussain (2016), and Filgona, Filgona and Sababa (2017) who found positive effects of using mastery strategies on learning retention of students in different subjects. Peladeau, Forget, & Gagne (2003) found the benefit led to enhanced long-term retention. This research showed that mastery was both impactful and had a positive effect on the student's performance. This is further supported by Samuel, (2007), Wambugu and Changeiywo, (2008), Olunfunmilayo, (2010), Akinsola, (2011), and Abakpa and Iji, (2012) all of whom reported that mastery learning, if effectively employed can enhance students' academic achievement in various school subjects.

In addition, the findings of the study support the findings of Iji (2005) and Elekwa (2010) who reported that effective instructional mastery strategy equally improved the performance of both high and low ability students. Thus, mastery learning approaches enhances the achievement of students of different abilities in a learning task. It was also observed that students possessed a positive attitude to the mastery learning instructional approach when used in teaching mathematics. Introducing more periods of mathematical mastery could therefore be beneficial to the teaching and learning of mathematics.

When considering the use of technology, we see that it has been used for numerous years in the effective teaching and learning of Mathematics. Teaching is in itself a complicated, dynamic, and progressive art that requires practitioners to adapt and alter their understanding (Leinhardt & Greeno, 1986). It then follows those effectual teachers can use their well organised, rich, and deep knowledge of their subject matter along with their comprehensive understanding of student learning and reasoning whether teaching and learning is face-to-face or online. Becker (2000) further explains that computers and technology serve as a prised and useful tool, which supports a constructivist pedagogy.

Therefore, using technology along with a mastery approach has potential to lead to good outcomes for learners. The mastery approach has many possible rewards. With the tenets of mastery, teachers are encouraged to look thoroughly at the GCSE syllabus in order to break it down into manageable chunks to construct and define learning objectives.

However, the approach to mastery that is described above does have some disadvantages. Arlin (1984) argues that the Time-Achievement Equality Dilemma is not correctly addressed within this model. It in essence states that having students achieve a required percentage on an assessment leads some to progress faster. Inevitably, with some requiring extra teaching or practice in order to successfully achieve that skill or objective. If we keep the achievement figure constant, time must differ. In further education, teaching time for GCSE Maths is far more limited than in both primary and secondary setting. This is a critical concern for effective mastery delivery models and so the model may have to be adjusted to fit with the timeframe for those on a one-year GCSE resit course.

In conclusion it has been shown many times that mastery strategies are effectual at developing learning retention and progression in both primary and secondary settings. Whether this can be effectively transferred to a further education setting has yet to be seen.

Methodology Data Collection

Across the ARG the majority of students had lessons for 3 hours each week with some having lessons for 1.5 hours per week. The students are from all vocational areas and are a mixture of abilities ranging from those who have previously achieved a grade 3 to a grade 1. All the students are seeking to achieve a grade 4 in mathematics or improve by at least one grade.

Over the course of this project, we collected a substantial amount of data. This data has taken a number of forms. We have collected two student surveys, an initial and final assessment plus eight weeks' worth of intervention assessments, which took the format of teacher observations along with a considerable quantity of quantative data from exam paper analysis. We further gathered data on confidence levels of students while using the online platform Desmos; the student was asked to complete a sliding scale and assesses their own confidence for each maths question along with a text box to allow any further comments they may have. At the end of the intervention, students were presented a certificate which highlighted the progress they had made over this time.

Surveys

Many researchers utilise surveys to effectively gauge responses to a stimuli. We decided to deliver the first survey two weeks into the process, that way students had seen our intervention strategy, and we then completed a final survey at the end of the intervention. The survey was given in class via Microsoft Forms and they were relatively short surveys with an average time of completion around 9 minutes. The first survey had a total of 23 questions and was made up of an array of open and closed questions. The closed questions primarily used a Likert scale. The goal was to get both quantitative and qualitative data. The survey had branching questions, so if a response was selected this would prompt their next question related to the previous input, often asking them to justify their opinion. We had 81 students complete the first student survey. The final student survey was slightly shorter at 19 questions and was based upon the initial survey. This was to measure how the students felt about the intervention. We received responses from 68 students for the final survey.

Intervention Design

Whilst planning and designing our intervention it was of the upmost importance that learners were repeatedly exposed to some of the highest impact and most frequently occurring topics. An in-depth analysis of the data from all exam series since 9–1 GCSE (2017) began so that the research group were able to identify the highest impact, frequently occurring topics. We then set about the creation of short, concise, repeated questions that were taken from the exam analysis. These questions were chosen as they are areas of mathematics that the average student who achieved a grade 4 could competently complete compared to an average grade 3 student. To determine this, we targeted the topics where there was at least a 10% difference between the average grade 3 and grade 4 learner. We then ordered these topics by questions that appeared most frequently. This is shown in *Table 1*. From this we were able to compile our 64 GCSE maths questions.

Table 1 – Comparing topics to student percentage scores

Individual Topics	Average of Grade 4	Difference between Grade 3 and Grade 4	Average of Grade 3
Percentages	63%	12%	51%
Compound Units	59%	13%	46%
Primes, Factors, and multiples	71%	12%	59%
Proportion	74%	10%	64%

Ratio	56%	13%	43%
Translate situations into an algebraic form	41%	19%	22%
Solve Linear equations	72%	14%	58%
Area	64%	19%	46%

Algebra is a concept that students find especially difficult to grasp, and in our analysis of the least likely questions to be answered correctly, one type of algebra question stood out. This was where students had to formulate a linear equation from information given, whether it be a shape, ratio, or other scenario. There is an interesting study by Drummond (2019) teaching linear and quadratic equations with algebra tiles. This study was developed to see how, instead of using the researchers' usual procedural methods with few visual aids, whether the applying of Bruner's Theory of Representation would enable a deeper conceptual understanding. The NCETM 'Five Big Ideas' (DfE 2020) were echoed throughout. Students would experience a range of representations of comparable questions with the objective of supporting all students to access a particular topic in a variety of ways whilst modelling connections between topic areas. Informed by the 'Five Big Ideas' and our literature review into this area, students were provided with representations of the lower order underpinning skills taught simultaneously with more complex problem-solving skills.

The four key **mastery** principles which outline the effective use of technology in a maths classroom suggest that in order to be effectively incorporated into a maths curriculum, any use of technology should provide 'new and insightful maths experiences", support independent learning, add value to the educational journey whilst selecting the right tools to do so and that it should 'use data strategically.' This was a feature which students were eager to see within the video learning resource, in addition to step-by-step instructions. This highlighted the importance of modelling appropriate mathematical thinking, which in turn would work towards facilitating the development of enhanced mathematical fluency and recall of skills among this cohort of learners.

Bruner's (1966) theory states that a pupil needs experience of all three levels of representational thought (enactive, iconic, and symbolic) before developing a conceptual understanding of the topic. More often than not, maths is taught by giving formulae and memorising procedures. However, by learning *procedure*, students are not necessarily developing a mastery of the topic. In contrast, by applying Bruner's Theory, the students were encouraged first to tackle the subject in an ***enactive*** way, using materials, or manipulatives to be able to understand. Then the ***iconic*** stage develops the mental imagery or representations but without using physical objects. Finally in the ***symbolic*** level, the student can solve the problem without either of these being necessary. Hence more 'tangible, action-oriented methods' are used before moving on to the more abstract, symbolic ideas (Bruner, 1966). The study highlighted how these methods were highly effective in enabling the student to attempt the more symbolic test questions with confidence.

These ideas to teach mastery, and build confidence were to inform the creation and implementation of our interventions. To do this we created exam style papers that students completed each week along with TikTok inspired videos that in essence were a revision aid and independent learning tool to help between each week's intervention. For each question of the intervention, we created a corresponding video which acted as a worked solution. In total, we had 10 weeks' worth of data. An identical initial assessment (IA) and final assessment (FA) were planned with an interim eight weekly interventions comprising a worksheet of eight exam-style questions and accompanying videos to be accessed via a Desmos activity. All this data was subsequently compiled and analysed using Microsoft Excel.

Due the contemporary nature of the resources, and the platform which was used to create them, students felt empowered to provide additional, informal feedback on the format of the video resources and this included requests to use large captions and to ensure that the music used does not distract from the overall message but that it should be both positive and motivational. They also confirmed that the sparing use of emoji's was encouraging and engaging; all features that they are remarkably familiar with due to their regular interactions with social media.

After the initial assessment was completed, it was apparent that the majority of the learners found the questions incredibly challenging. Due to the feedback from the initial assessment and the assessments of the continuing weeks, adaptations were applied to the original planned methodologies. The main aim of these adaptations was to keep the learners engaged and help them to improve on previous week's scores. Initially a flipped classroom approach was trialled during the first four weeks, with learners then independently accessing the video resources as they felt appropriate. Learners' independence outside of the classroom was strongly encouraged, although over time this evolved into their 'independence' taking the form of making self-directed choices in the classroom as to whether the video resource was utilised at the same time as attempting the exam questions each week.

During the final four weeks the strategy was adapted slightly and we began to watch the resources as a group, and then allowed students to revisit as required. This heightened peer support and interaction, and facilitated in depth discussions, encouraging deeper engagement which would prove to have a positive impact on the score that they went onto attain.

Ethics

As a group we discussed the ethics of the surveys via online meetings, and we decided to put the ethic statement at the beginning of each survey. The students then had to tick a box to show they had read and understood the statement. It outlined what they survey was for, why the information was asked and how the results would be used. It clearly outlined that all the responses were anonymous, that no personal data would be taken or that they could withdraw from the survey at any time. The reason for the study was explained thoroughly to make sure all were aware that the research would help inform the maths GCSE FE teaching regarding a technological mastery-based approach.

Results

Across all the colleges, we initially had 130 students involved within the intervention. Inevitably due to issues with attendance, withdrawals and timetable constraints, we have a number of gaps within our data set. This equates to 814/1300 ≈62.62% assessments completed. As we have a number of students who only completed a small amount of the intervention, the group decided that to try to show any meaningful data, we would discount all the students who had not completed both the initial and final assessment. This then brought a more reasonable 511/680 ≈75.15% assessments completed. This can be more clearly seen in the *Table 2* below.

Table 2 – Showing the number of students and the number of interventions they completed.

Number of Interventions Completed	Frequency		Number of Interventions Completed	Frequency
1	4		-	
2	9		2	1
3	9		3	1
4	7		4	3
5	15		5	4
6	22		6	11
7	21		7	15
8	21		8	12
9	13		9	12
10	9		10	9
Grand Total	**130**		**Grand Total**	**68**

From this point forward, assume we are discussing the results relating to the 68 students who completed both the initial and final assessments unless otherwise stated.

Initially to see if our data is statistically significant, we can set up a hypothesis test:

H_0: There is no difference between the sample means of the initial and final assessment

H_1 : There is difference between the sample means of the initial and final assessment

The results from the initial test (Mean=19.17%, Standard Deviation =16.06%) and final assessment (Mean = 43.07%, Standard Deviation = 26.76%) indicate that the intervention did have an improvement. By use of a paired t-test, T (68) =9.17, p<0.01. These results can be further detailed below in *Table 3*.

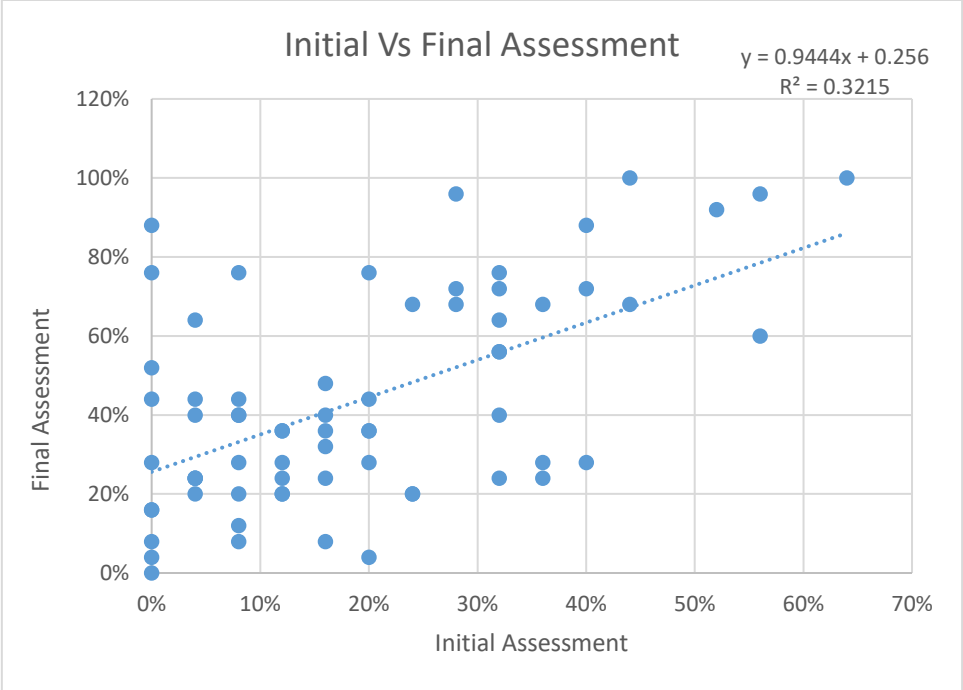
Table 3 – Paired t-test

	Final Assessment	*Initial Assessment*
Mean	43.71%	19.18%
Variance	7.16%	2.58%
Observations	68	68
Pearson Correlation	0.567041888	
Hypothesized Mean Difference	0	
df	67	
t Stat	9.169323196	
P(T<=t) two-tail	1.90577E-13	
t Critical two-tail	2.651219685	

The average difference between the two assessments scores is +24.53%, 99% CI [15.32%, 33.74%]. As we see by our t-value, we must reject the null hypothesis. We can assume that our results are statistically significant.

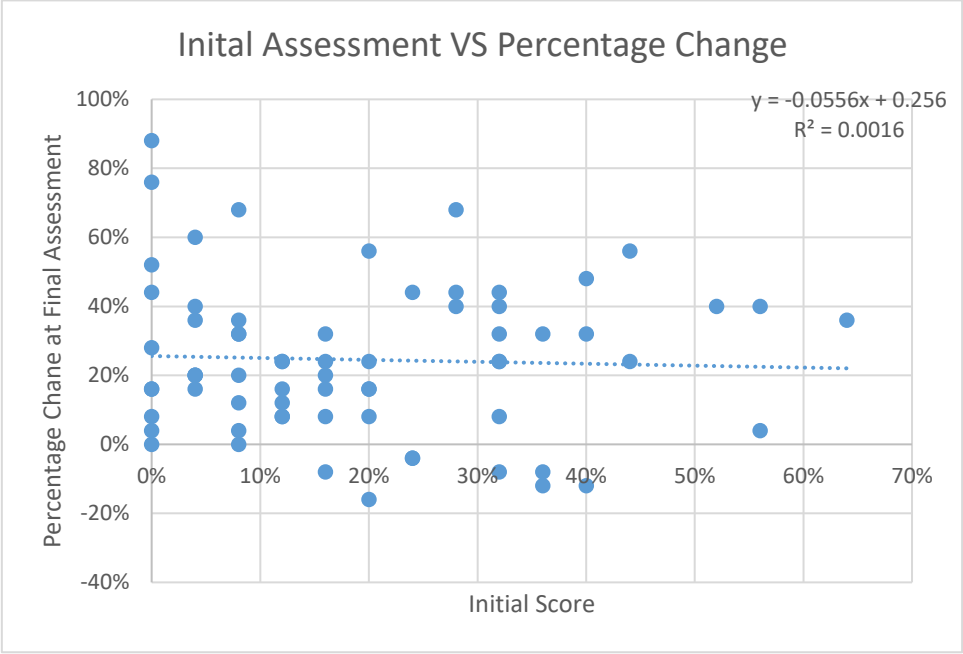
We first looked at the data and created a scatter plot to evaluate whether there was a relationship between the initial and final assessment score. This is shown below in *Figure 1*:

Figure 1 – Comparing the Initial and Final assessment score



The chart shows the $R^2 = 0.3125$, this shows a very weak positive correlation between the two data sets suggesting a limited relationship. If we can look more closely at this data to see if a relationship does exist. If we consider the percentage change from the initial to final assessment and then compare that data with their initial score, we then get the following scatter graph below (*Figure 2)*.

Figure 2 - Comparison of the initial assessment vs percentage change

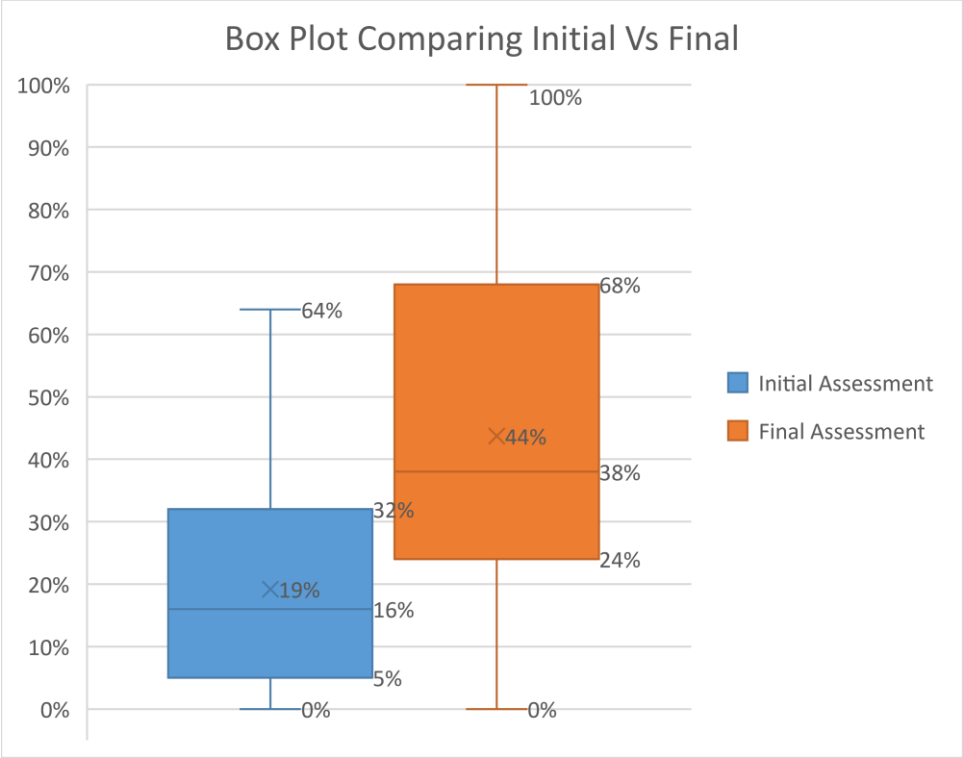


As we can see the R^2 value suggests no correlation, which implies that the students who performed poorly in the first assessment improved and could still achieve the same progress as those students who performed well in the first assessment. So our intervention was not biased towards helping the more

proficient students compared to the less able students. As we can see on the y axis, the vast majority of students beat their score when they came to the final assessment. In fact 90.91% of students maintained or improved their score over this time, with an average improvement of 29.00% across these students and 24.53% over all 68 students.

To compare the data more clearly, the box plot (*Figure 3*) reveals further results that are compelling.

Figure 3 – Box plot showing how students performed in the initial and final assement



We can highlight some very interesting results. The median for the final assessments is above the upper quartile for the initial assessment. We can see that the median result itself rose 22% during this intervention, along with the mean, which is shown as an x on the plot. (*Figure 3*) We see that the Inter Quartile Range (IQR) has increased in the final assessment from 28% to 44%, which could be expected as students responded differently to stimulus. We further see a far greater range of scores during the final assessment with some students, two in fact achieving 100%. It is interesting to see that the upper quartile for the initial assessment is 32%, whereas for the final assessment the lower quartile is 24% which is only 8% difference.

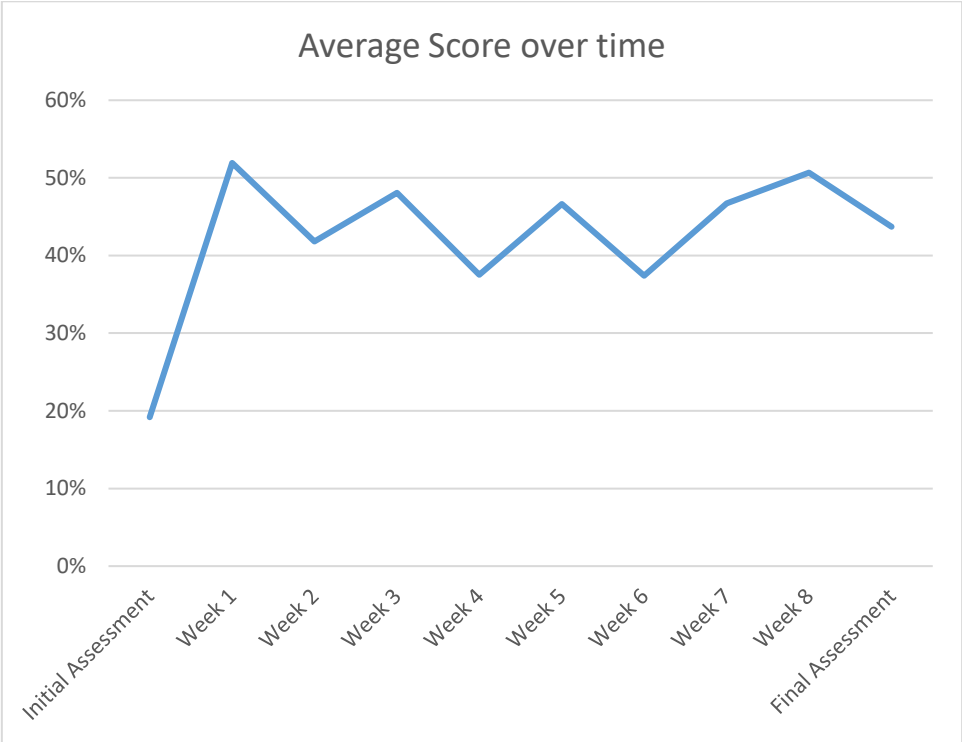
This can be broken down even further (*Table 4).* It is anecdotally accepted that often the more proficient students will tend to progress faster or perform better. If we were to consider the question “would this intervention only be helpful to grade 3 or the most able students?”, the following table shows that actually all students are making progress. With those who scored in the lowest 25% with an average score of 2% in the initial assessment actually progressed by 32% by the end of the project. As we can see as an average all students do, in fact, make progress on their initial score. This shows our least and most able progressing by the biggest margin.

Table 4 – Students are broken down into 4 groups to see how they performed

Position	Number of students	Average of Initial Assessment	Average of Final Assessment	Progress over project
4th Highest quarter	17	41%	68%	26%
3rd Quarter	17	23%	44%	22%
2nd Quarter	17	11%	29%	18%
Lowest Quarter	17	2%	34%	32%
Grand Total	**68**	**19%**	**44%**	**25%**

Taking the averages of each student's score each week we see the following graph below. *(Figure 4)*

Figure 4 – Showing average percentage score over the course of the intervention.



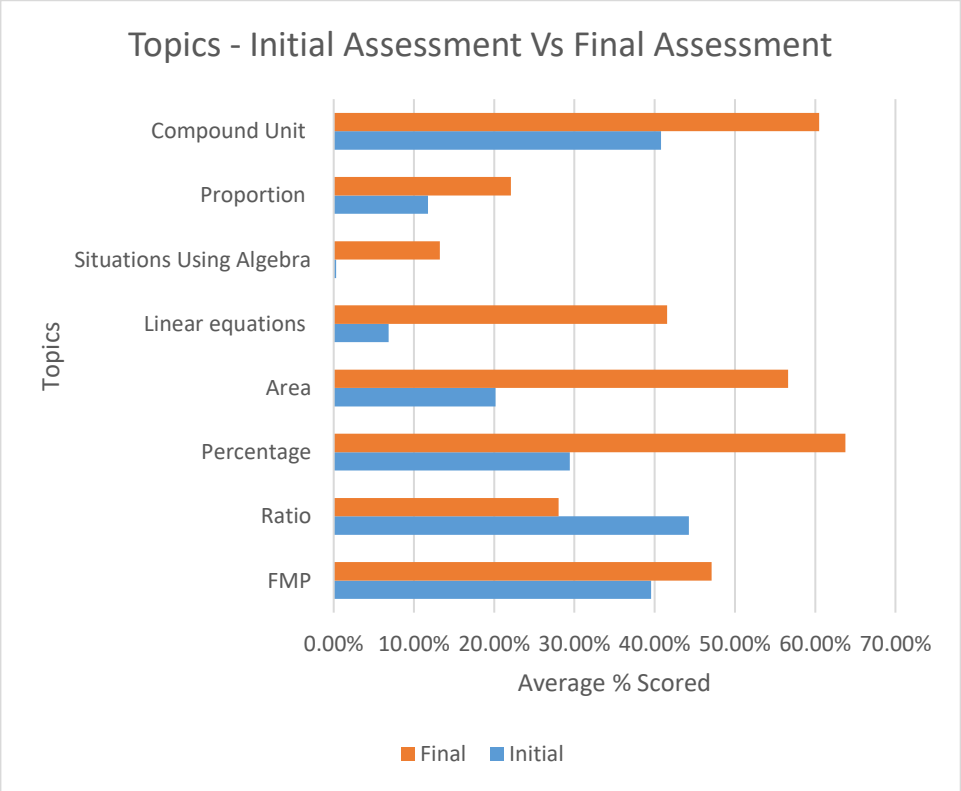
This shows a pattern of peaks and troughs as we worked through the intervention each week. The increase is steady and gradual over the 10-week period. This was of course to be expected as the questions varied each week. It is clear that from the first week to the second week, when given support, students' scores did dramatically increase. Students' average scores then modulate for the weeks of the intervention. However, their scores improved very notably between the initial and final assessment.

Table 5 – A breakdown of each topic in both the initial and final assessment

Topic	Initial	Final	% Change
FMP	39.55%	47.10%	7.55%
Ratio	44.25%	28.03%	-16.22%
Percentage	29.41%	63.77%	34.36%
Area	20.15%	56.62%	36.47%
Linear equations	6.86%	41.54%	34.68%
Situations Using Algebra	0.29%	13.24%	12.94%
Proportion	11.76%	22.06%	10.30%
Compound Unit	40.81%	60.51%	19.70%

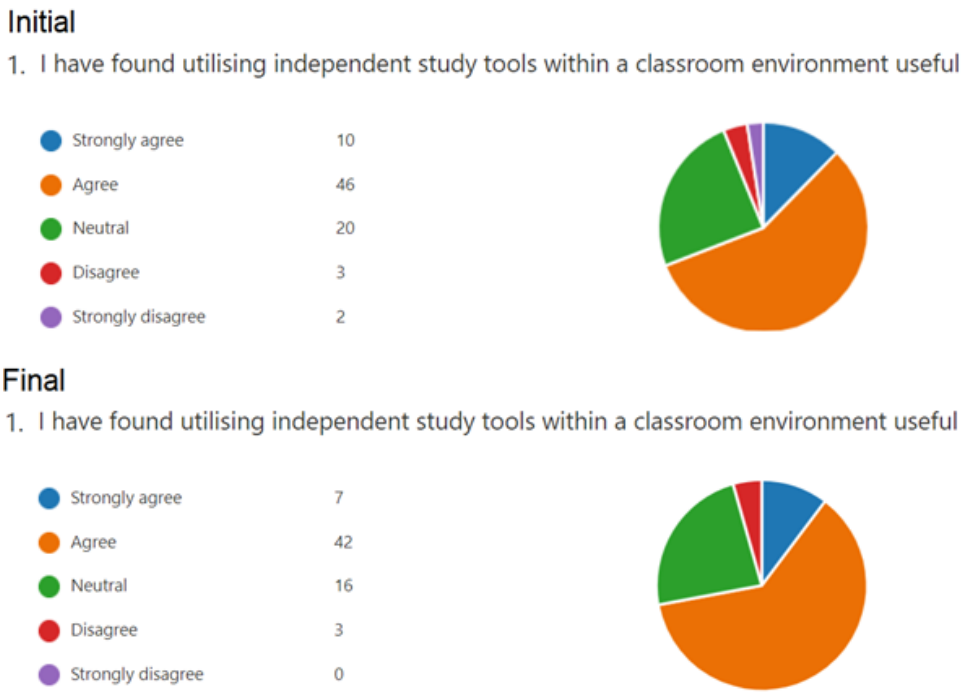
If we start drilling down to individual topic areas that are assessed in the intervention, we see some quite interesting results. *Table 5* above and *Figure 5* below show the percentage score for each of the eight topics. We can see that area, percentage and linear equations are the topics where students have shown the most improvement. Percentages were also the topics that were answered the best in the final assessment. Conversely ratio was the worse answered topic area, even making negative progress. This we believe is due to the nature of the question we picked. Initially the areas involving algebra were the worst performing. Even after the intervention only 13.24% of the marks for “Situations Using Algebra” were achieved. We used several mastery multiple representations ideas to show effective methods to complete this style of question.

Figure 5 – Topics – Initial Assessment vs Final Assessment



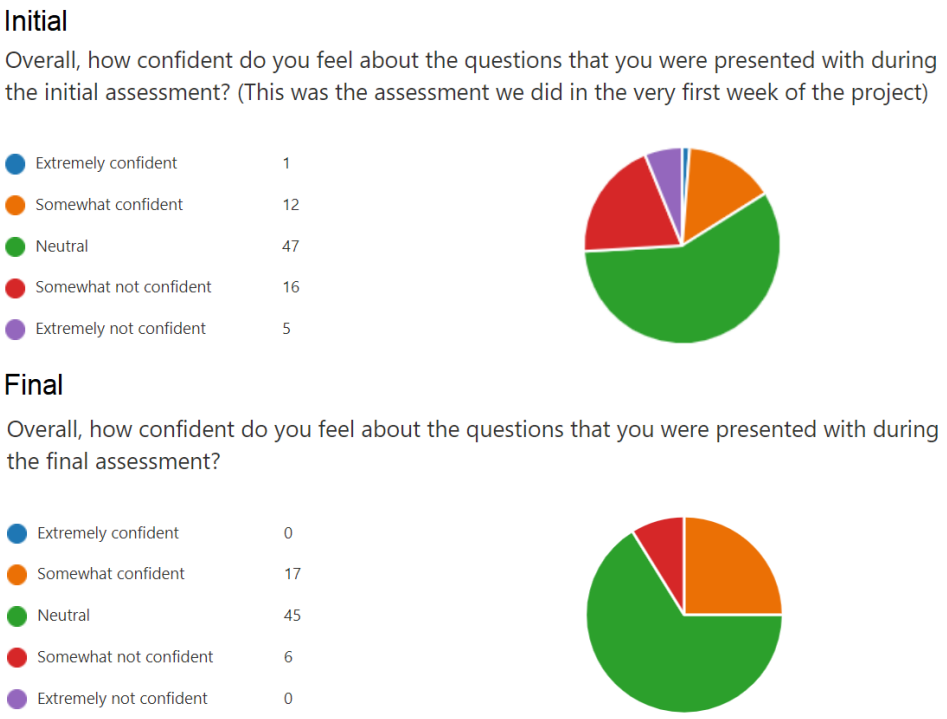
Survey Results

Figure 6- Utltising Independent Study Tools – Initial Assessment vs Final Assessment



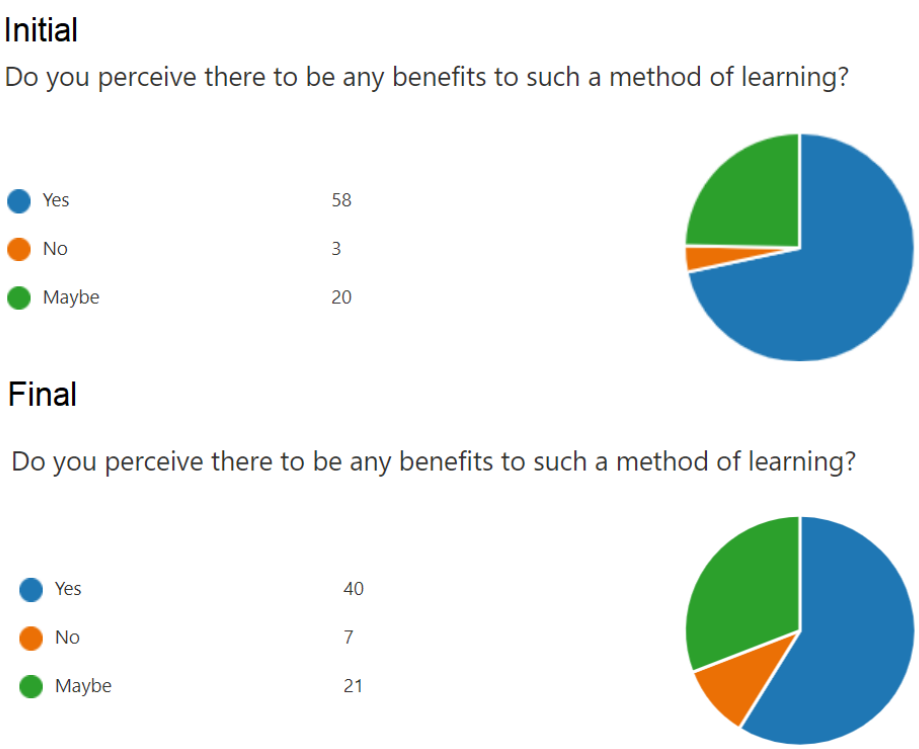
When we created our survey, our goal was to measure student views over the project. The chart above *Figure 6* shows how students responded to utilising an independent study tool within the session. The results were quite positive during the initial survey, 58% either “agree” or “strongly agree”. This then rose to the score of 72% during the second survey. This shows that such a strategy has changed several students’ perspectives across the project.

Figure 7 Confidence Levels - Initial Assessment vs Final Assessment



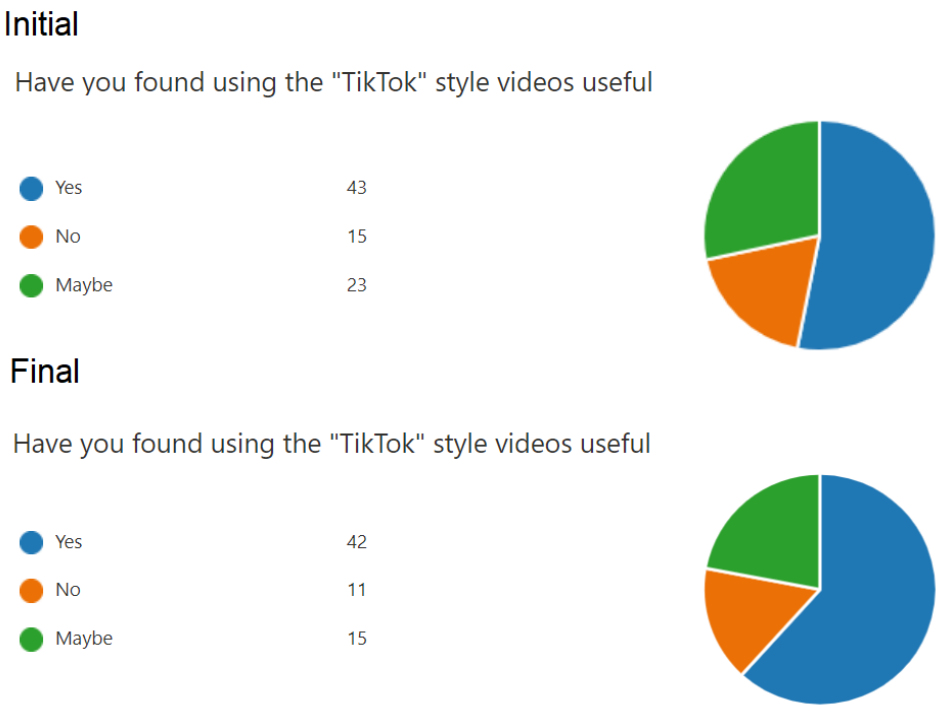
Student's confidence can have a massive impact on the successful completion of a question (see *Figure 7*). Over the time of the project, we have noticed students enjoy seeing the progress they are making each week within the topics. We can take some interesting notes concerning *Figure 7*. When students completed the initial assessment, around 26% were with "Somewhat not confident" or "Extremely not confident". This could be expected as it was early in the year and they had some exposure to exam style questions up to this point. It is fascinating that in the final survey no student selected those options. Overall students did become more confident with these styles of questions. There was an increase from 16% to 25% for those who selected "Somewhat confident" or "Extremely confident". There is of course numerous research linking perceived confidence with actual ability.

Figure 8 Percieved Benefits – Initial Assessment vs Final Assessment



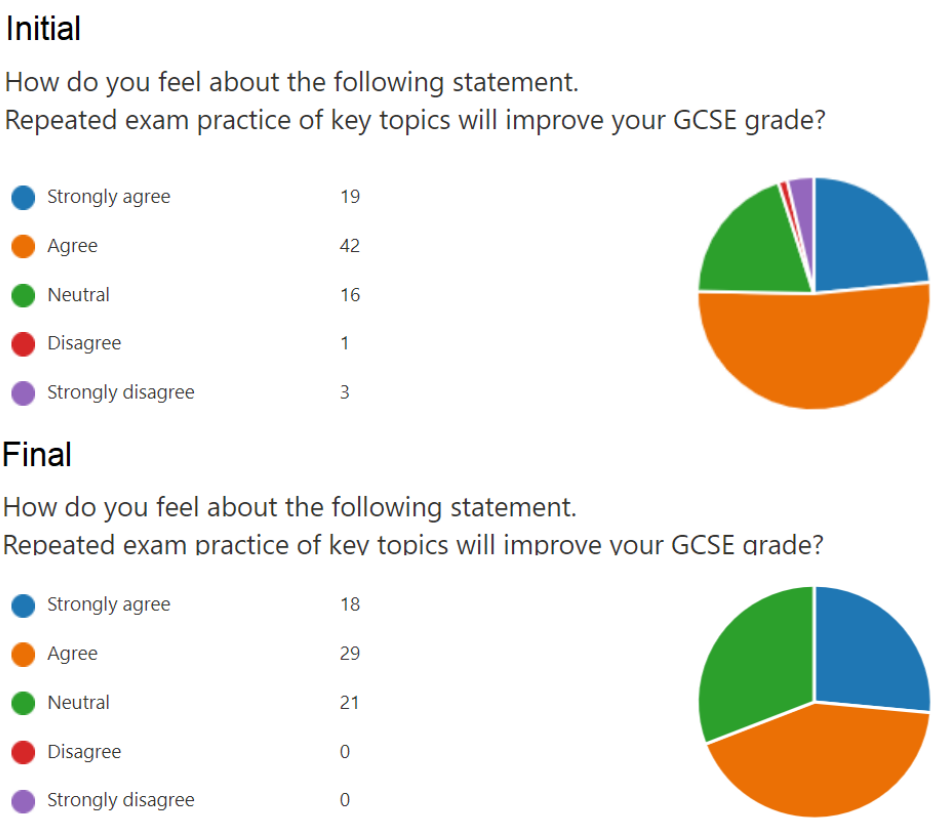
In the graph above *Figure 8* we see that the percentage of students who see a benefit to this method of learning has decreased from 72% to 59% over the course of the project. If they selected "No" or "Maybe" a branching option was added to provide some qualitative reasons. Some students felt that they struggled to learn this way. Those students felt that they prefer to have a physical teacher instead of being lead via a video. It is quite interesting, as the majority of students liked the idea of using background music, albeit they questioned our choice of songs! Some felt that the videos would have been better with dictation over the top of the video to explain how to complete each step. This would defeat the point of the videos as the style we chose when we discussed and implemented idea. We wished the videos to be as close to a TikTok style as possible. Some liked the idea that as they were quite short; they could continually replay the videos until the topic "clicked" with them.

Figure 9 – Videos Usefulness – Initial Assessment vs Final Assessment



We asked if the students have found the TikTok style videos useful to learn and engage with the materials. The results are shown in *Figure 9* above. For those who agreed 'yes' this rose from 53% to 62% during the length of our intervention. Those who selected this liked it because it was an effective way to visualise the problems, it was a different method of learning and it was a short, sharp, simple video. These students also felt that we broke the questions down as simply as possible into single staged steps which helped them access each stage. Those who selected "No" or "Maybe" were asked why they selected these options. They felt that they were quite rushed and that they struggle to learn that way. They also stated that it was too fast and that the videos for the questions that were multistage problems were hard to follow.

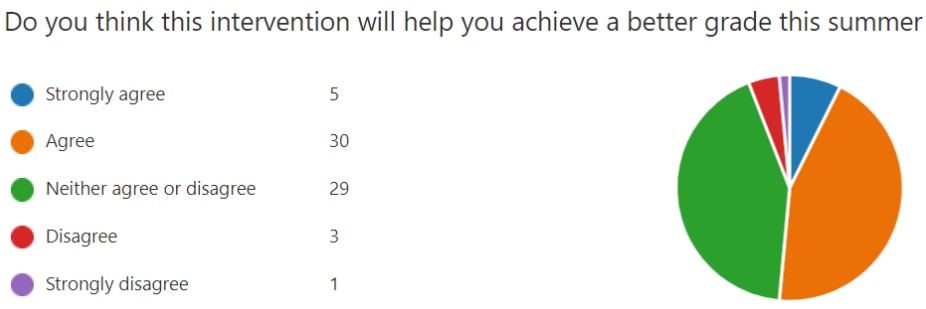
Figure 10 – Repeated Exam Practice – Initial Assessment vs Final Assessment



We asked students how they felt about repeated exam practice of key topics and whether they felt it would improve their grade. The results are shown above in *Figure 10*. As the project progressed, we continually highlighted these topics as key areas that will seek to improve their final summer examination grade. During our initial survey we found 5% of the students felt that this exam practice would not help them improve their GCSE grade. By our final survey, this had dropped to 0% and the vast majority could see the importance of exam practice in order to learn, revise and perfect exam techniques.

The results for the last question we asked in the final survey are shown below in *Figure 11*. We did not ask this question in the initial survey. As we can see 51% of students agreed with the statement. The students that selected these two options were then asked to explain why. They suggested that it was the quick concise videos that made the work easier that allowed them to access more of the topics that they previously would not have attempted. They felt that the videos helped them understand difficult topics and areas of mathematics that they had previously not been able to grasp or comprehend. Conversely, those who disagreed with this statement felt that it took away from the student teacher relationship and so they struggled to learn this way.

Figure 11 – Grade Improvement Perception - Initial Assessment vs Final Assessment



Teacher Observations by individual members of the Action Research Group

Teacher Observation – Louise Bentley – Buxton and Leek College

General Remarks

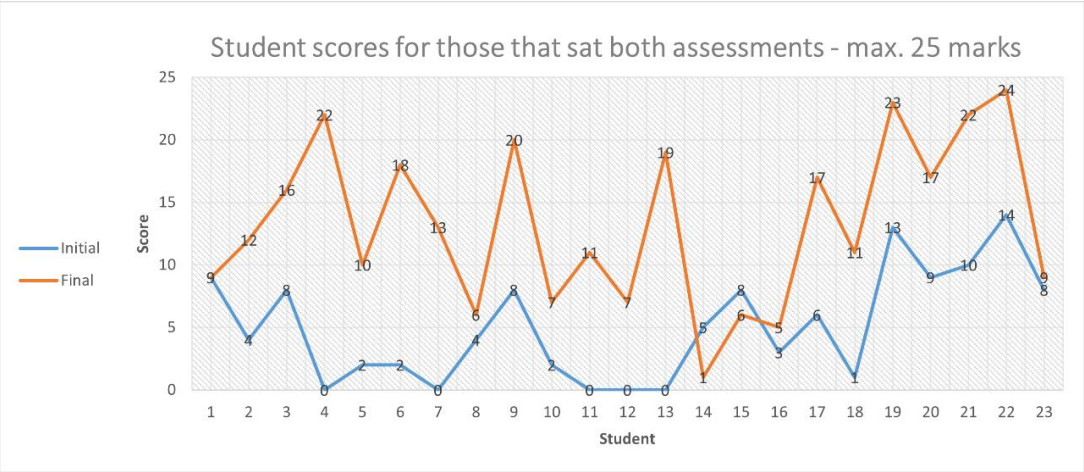
An element of maths anxiety was removed by using a platform they were familiar with and the students were engaged with from the start. I initially allocated 30-40 minutes each week, but most lessons extended for up to an hour, partly because the students were so absorbed in the activities and I wanted them to continue. The first three weeks were using the eight questions along with the same question repeated on the video, of various lengths and styles. The following weeks I either used videos of the exact question or a shadow question with a similar method. The IA and FA were done with no help from videos or class discussion. As the weeks went on, I found the interventions a little repetitive, so we varied the tasks slightly. For example, in week 5 the students were given the worksheet without the videos to start with. Once they had completed as much as possible, we then watched each on screen together creating opportunities for rich discussion. I would say something like 'Now let us now see how the teacher does it…,' 'Do you agree with the method?' 'Would you do it differently or stick with your way?' 'Is the answer reasonable?' 'What do you notice?' On a couple of occasions students spotted a mistake that I had made in a video, which shows they were paying careful attention.

An interesting side benefit was that I had to completely re-think my own way of teaching. Instead of having a PowerPoint presentation with numerous slides we had around 60 seconds to explain a multi-step GCSE exam question, and even more specifically – without speaking – to the background of chart hits. From my observation I saw that the students were used to working like that, they were absorbed in the task and replayed the videos over and over. The videos varied in style from cartoon characters to represent the parts of the questions, drawing diagrams, bar-modelling, and post-it notes to highlight key mathematical concepts or formulae. We also made use of the platform's features such as adding stickers, flashing gifs or polls. (See *Appendix.*)

Student Results

The overall data for my classes shows an increase from an average score of 5 out of 25 marks on the initial assessment to 13 out of 25 on the final assessment which is a 32% increase across the whole group. The chart below (*Figure 12*) compared each individual student's two assessments. Of those who reported only a very slight increase or even decrease were those who had missed **3 or more** of the interim worksheets (students 14, 15 and 23).

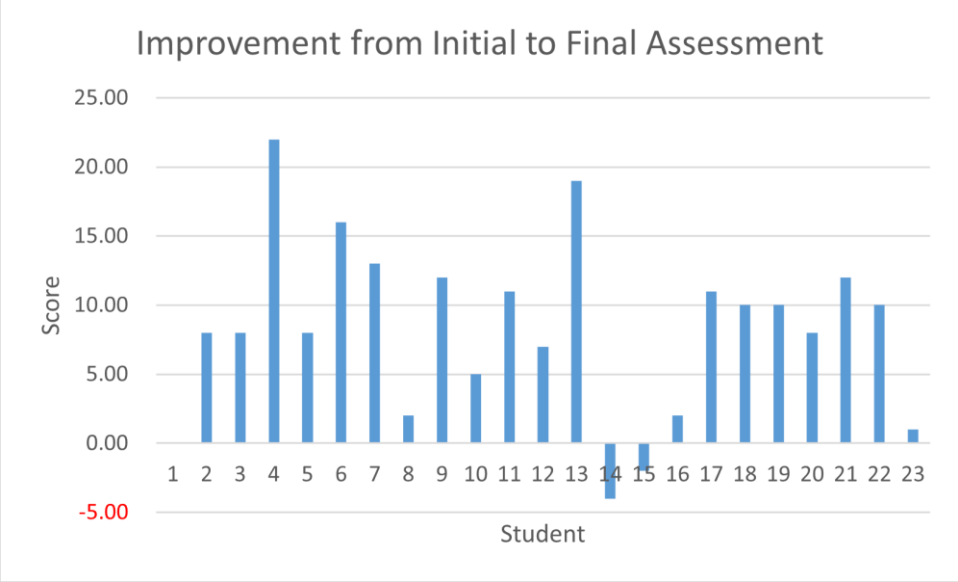
Figure 12 – Chart showing student scores who sat both assesments



On the initial assessment there were 5 students who were unable to do any of the questions correctly, however they all showed substantial progress and student 4 went from scoring zero to 22 out of 25 in the final assessment showing a considerable 88% increase. The students in general were not aware of their marks throughout the intervention, however on conclusion, certificates were awarded to each student for their participation along with their scores. Student 4 commented that he was feeling much more confident with those type of questions and was extremely pleased with the progress he had made.

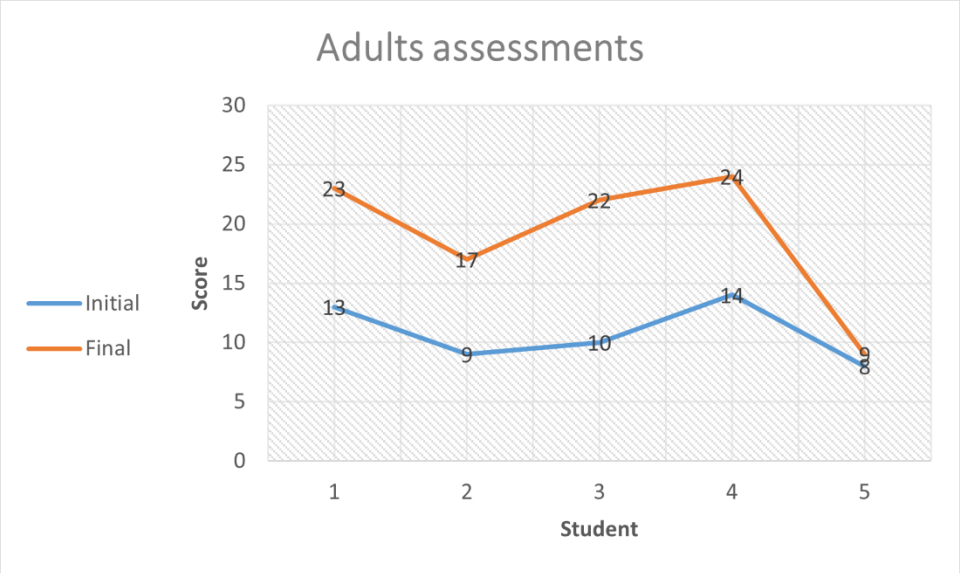
The graph below (*Figure 13*) shows the raw score increase across the whole group.

Figure 13 - Chart showing progress from intial to final assessment



It is of interest to compare the data for the adults alone, and as the chart below (*Figure 14*) shows, they had a higher starting average of 10 out of 25 for their initial assessment and 19 out of 25 average score was obtained on the final assessment, thus a **36% increase** overall.

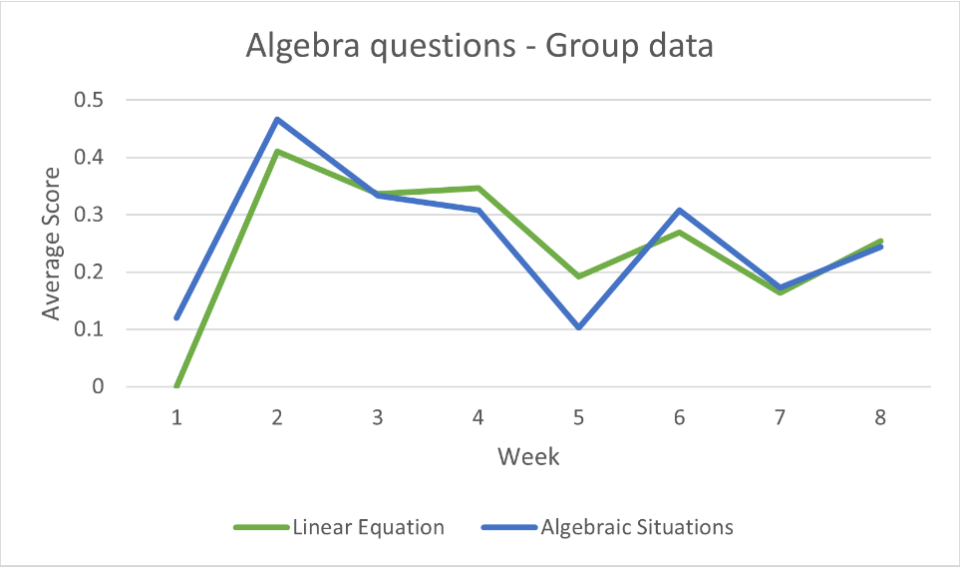
Figure 14 – Chart showing Adult learners progress



Question Types

The questions that proved more difficult were where the student needed to form a linear equation - these appeared twice in each intervention albeit in slightly different formats. It could be in the form of a ratio or other scenario where ‘x’ needs to be assigned to a component and then the rest is compared to this one, or where a shape is given with the side lengths in algebraic form. As observed in the figure below, although most of the students still did not manage to get full marks, there was an improvement in abilities. The peaks are where the videos were used alongside the worksheets. Week 5 was without videos until after the worksheet was completed, and in week 6 and 7 they were optional. Reliance on the videos reduced noticeably as we reached weeks 6 and 7 until we got to the final assessment which the students worked through fairly confidently without any support.

Figure 15 – Chart showing Algebra style questions througout project



What can we draw from the data? The repeated exercises along with the variety of visual ways of presenting the methods certainly achieved more than I had imagined. However, was it the fact that they were using their *smartphone* alongside the mastery technique that made the difference? Would the same results have been achieved using algebra tiles or Cuisenaire rods? Previously published literature on affective studies showed in one case that the use of a students’ own mobile device promoted 'positive emotions in students towards the study of mathematics, such as enjoyment, comfort, pleasure, enthusiasm, interest, feeling of time passing, and curiosity' (Borba et.al.,2016 p. 592). As such I would like to suggest that it was a combination of the two, which boosted the student’s motivation and engagement and thus contributed to the achievement that was obtained.

Teacher Observation – Laura Butt – Telford College

Due to the small cohort involved, Telford College was able to pay particular attention to learner experience, student voice and any change in engagement with the tasks at hand throughout the course of the intervention. It was possible to assess perceived confidence levels and learner feedback alongside performance data, meaning that this can be analysed whilst considering the planning and implementation of an intervention of this kind in the future.

Student Responses

In an effort to capture the initial thoughts of the intervention group the first question posed asked learners **'How do you feel about utilising independent study tools within a classroom environment?'** Below is a summary of the opinions of the cohort, the responses range from:

- 'I like it'
- 'It's cool'
- 'I feel mainly confident as I like to work on my own and figure out solutions on my own, although I do sometimes like the help from others. I also sometimes find it easier to remember information when I find it myself rather than being only told, as I am not always good at absorbing information.'
- 'Good I think it will be a great tool to use in the classroom especially the videos will be beneficial because I am a visual learner so seeing someone do it and me having a go at it, I think that helps me better so I hope when we get further into the project it will really help me because I really want to get a 4'.

During this initial data capture all students surveyed responded positively to the question. Some students were able to articulate their understanding of the value in their being empowered to seek and retain information. They saw the value in being exposed to similar problems and a variety of modelled solutions and had a good understanding of their own learning style. Of the 6 responses 3 students had previously used independent study tools and 3 had not.

Students were then asked '**Do you perceive there to be any benefits to such a method of learning?** Four students responded to this question positively, whilst one highlighted their reservation, and one learner did not comment. The range of their responses, prior to embarking on the intervention are listed below:

- "I think it is good to have independent learning tools as you will not be always able to rely on others and you may have to find way to teach yourself."
- "Yes because it's being taught to me rather than being piled with work and loads of books"
- "Helps understand how to do it''
- "I like having one to ones with the teacher"

On asking the same question following the intervention, learners responded in the following ways:

- "Being able to learn new methods throughout the process"
- "Using algebra to help me figure out the equation to get the answer."
- "It is useful to do at home and outside at college"
- "It helps everyone as if the teacher was giving out a one on one to everyone at the same time."
- "That I can work better when it is taught in front of me."

Students could articulate specifically the impact that the intervention had had on the progress of their learning. One student expressed a desire to be taught in a more traditional way although we are unable to see the evolution of their viewpoint as they did not complete the initial survey.

All students involved in the intervention, across all colleges, accessed the resources via Desmos. In order to capture their change in perceived confidence over time we asked them to consider their confidence levels by question and log this using a sliding scale whilst they were completing the questions, alongside the initial and final survey. It was intended that his would not only allow the student time to reflect on this particular aspect of their journey, but it would also ensure that the tutors involved were able to capture and respond to this accordingly.

The table below (*Table 6*) shows the change in confidence scores between the initial assessment and final assessment.

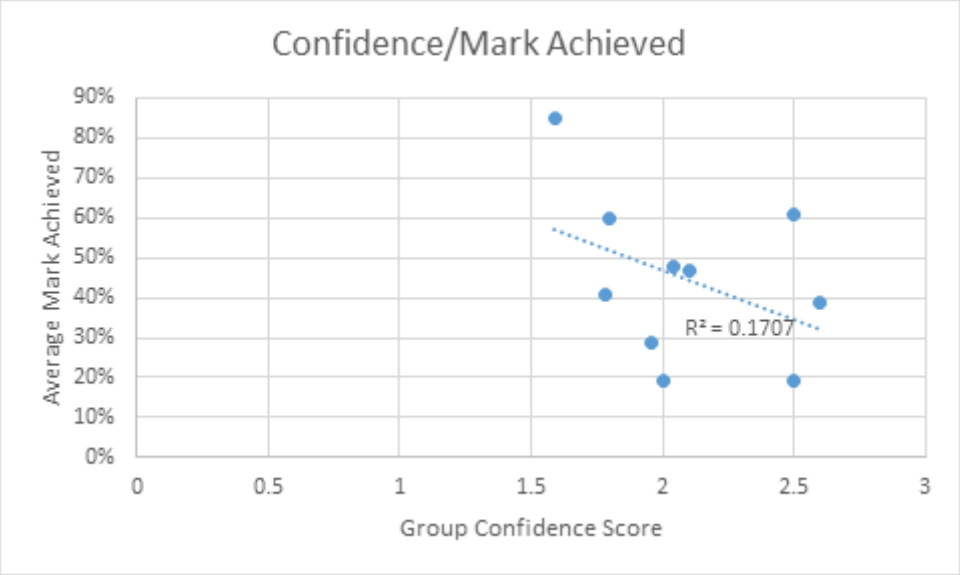
Table 6 – Confidence scores between the assessments

	Initial Assessment	Final Assessment
Overall, how confident do you feel about the questions that you were presented with during the initial assessment?	★★☆☆☆ 2.00 Average Rating	★★☆☆☆ 2.00 Average Rating
How confident do you feel in using a platform which encourages you not to directly ask questions of your tutor?	★★★½☆ 3.50 Average Rating	★★★☆☆ 2.80 Average Rating

When asked specifically about the questions that students were presented with all students reported an increase in the confidence over the duration of the intervention. The survey has also allowed for us to identify a decrease in perceived learner confidence with the platform and allows for teacher researchers to consider any adaptations to the approach towards an intervention of this kind in the future.

An interesting relationship between confidence and marks attained by individual learners emerged, students had self-assessed a decrease in confidence in using such a tool, at an average of 0.7 points on a Likert Scale, detailed in *Figure 16* below.

Figure 16 – Learner's confidence vs average marks achieved



A very loose, negative correlation can be seen between group confidence scores and the overall percentage of marks achieved. Despite a visible decrease in perceived confidence whilst utilising the tool being evident, an increase in confidence with the questions which students were presented with, positively impacted the progress of their attainment in marks.

On assessing perceived confidence levels, it is important that these are considered against the marks that students went on to achieve, detailed in Table 7 below.

Table 7- Percentage score by topics for the initial assessment

Initial Assessment						
FMP	**Percentages**	**Area**	**Linear Equations**	**Situations Using Algebra**	**Proportion**	**Compound Units**
0	0	0	0	0	0	25
100	0	0	0	0	0	0
0	25	25	0	0	0	100
50	25	0	0	0	0	0
0	0	0	0	0	0	100
0	100	50	100	0	100	100
0	0	0	0	0	0	50

Table 8 shows the percentage of marks achieved by topic area during the final assessment.

Table 8 – Average percentage score for the final assessment

Final Assessment						
FMP	**Percentages**	**Area**	**Linear Equations**	**Situations Using Algebra**	**Proportion**	**Compound Units**
0	50	50	66.7	0	0	100
50	75	0	0	0	100	100
50	0	50	66.7	0	0	0
100	50	0	33.3	20	0	100
100	25	50	0	0	0	100
100	100	100	100	100	100	100
0	25	50	0	0	0	50
100	0	0	0	0	0	0

Whilst undertaking an analysis of the marks attained by the cohort it is important to differentiate between where students had made an attempt at a question and scored zero or where the student scored zero marks as the impact of having made no attempt at a question. Where zero is recorded and highlighted red, this indicates that no meaningful attempt was made at a question.

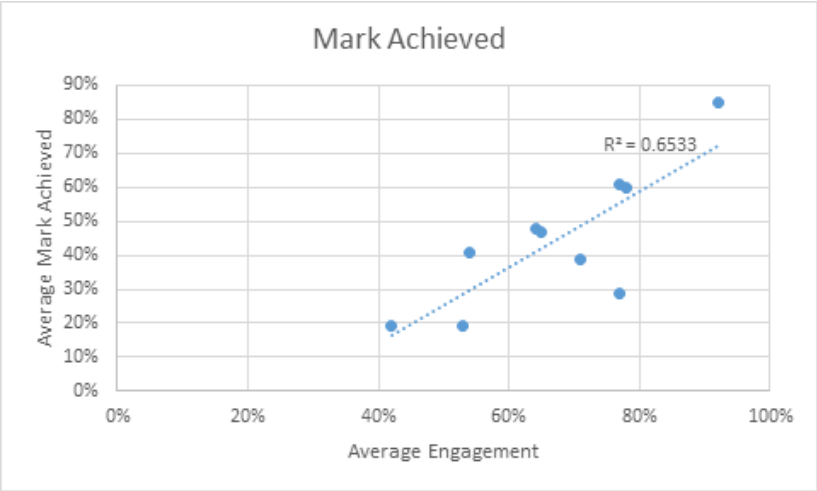
There was a notable change in the number of topic areas in which students made meaningful attempts. During the initial assessment only 53% of questions were attempted whereas during the final assessment an impressive 71% of questions were attempted.

Table 9 -Details the development of confidence, meaningful engagement, the percentage of marks achieved and video usage by group, by week.

Week	IA	1	2	3	4	5	6	7	8	FA
Engagement	53%	78%	64%	77%	42%	65%	54%	92%	77%	71%
Percentage of Marks Achieved	19%	60%	48%	29%	19%	47%	41%	85%	61%	39%
Video Usage (Whilst answering question)	-	39%	21%	27%	8%	20%	23%	48%	13%	-
Average Confidence (5-point Likert scale)	2.0	1.8	2.0	2.0	2.5	2.1	1.8	1.6	2.5	2.6

Figure 17 details the relationship between the percentage of meaningful attempts made at a question and the percentage marks achieved by the group.

Figure 17 – Average mark achieved vs average engagement



A strong relationship is evident between the percentage of questions that students attempted, and the percentage of marks achieved. The importance of making meaningful attempts at all tasks delivered is evident here and whilst it is best practice for learners to explore their own progress data, student understanding of the importance of full and meaningful engagement can go some way towards overcoming the fixed mindsets that are so often a familiar feature of Maths GCSE resit classrooms, which is supported by a wealth of literature which focuses on this area.

The increase in meaningful student engagement over the course of intervention suggests that students had, to a degree, successfully retained and recalled the required skills as a result, but most importantly were willing to attempt, overall, almost three quarters of the final assessment, supported by the application of the skills learned over the previous weeks. Video resources were not made available during the initial and final assessment.

Considering the focus of the intervention, this willingness to engage and subsequently the increase in marks attained is likely to be a direct result. The main objective was for the short, engaging video resources to deliver concisely the necessary skills, steps, and approaches in a minute or less, in a variety of ways.

Students became more confident whilst they acquired the skills required to reason, recall, and solve complex problems having explored these particular topics through resources that had been designed according to the key principles of mastery. The engagement data suggests that the intervention developed learner resilience and stamina whilst approaching more complicated problems, those that they had previously been less likely to attempt as identified during the initial assessment. It is likely that students were able to recall a variety of skills from a variety of resources, rather than adhering completely to one of the instructional methods which support Gains idea (2001) that retention and recall is paramount to student success, whilst also supporting May's argument (2013) that consolidating the bonds between previously met and recently learned skills acts as a catalyst for the speed at which learners progress. A relatively short intervention has, here, produced impressive results in this area.

Teacher Observation – Mandy Handley – Newcastle College

Not all GCSE resit students have previously achieved a grade 3. Most students I teach have below a grade 3 as their previous GCSE mathematics grade. Many of the students had achieved a grade 2 with some of them achieving a grade 1 in the previous academic year. We felt that this is an issue many colleges face and therefore we should include how we slightly adapted the intervention to meet the needs of the students.

Adapting Methodology

As previously stated for the combined results only the students that completed that both the initial and final assessment were included. However, for this observational study, it was decided to include all the data for all my learners.

These were a slightly different level of learner, so it was slower and had more structure. The adaptations below were made as a result of observations during the lesson and verbal feedback from the learners. Quite early on in the process, I felt that the topics chosen were challenging for the majority of my learners but was hopeful that the mastery approach would help them to improve. The weaker of my 3 groups struggled with the intervention and never settled to it as well as the other 2 groups. This made it more difficult for them to take in the information. I emphasised the need for these students to focus on less topics and guided them to specific questions each week. Every student was made aware that having the confidence to at least start a problem and gain a few marks was a huge achievement and would make a significant improvement on their results. Due to the feedback of the initial assessment and the assessments of the continuing weeks, numerous adaptations were applied to the original planned methodologies. The main aim of these adaptations was to keep the learners engaged and help them to improve on previous week's scores.

The amendments to the methodology plan are detailed below.

Initial assessment

- 25 minutes provided – students completed under exam conditions

Week 1 intervention

- Expressed disappointment that only 3 learners had accessed TikTok videos
- Demonstrated how to access and use TikTok videos as a teaching aid
- Provided a worked copy of shadow questions alongside the assessment.
- Allowed 20 minutes to complete the questions

Week 2 intervention

- Due to lack of uptake watching TikTok style videos, each group was given 20 minutes to work through videos in class and make notes

- Allowed 20 minutes to complete week 2 assessment
- Discussed common formulae needed to complete the work

Week 3 intervention.

- Provided 25 minutes for TikTok style videos in class, 20 minutes for assessment
- Supported learners on an individual basis as they were watching the video clips
- Emphasised that weaker learners should focus on 4 of the 8 questions only.
- Highlighted the positive relationship between the 8 focus topics chosen and the examination board's announcement regarding the topics to be assessed in the upcoming summer exams
- Posted the following week's TikTok videos after the lesson

Week 4 intervention.

- Explained 2 questions on the Interactive Whiteboard (IWB) to all learners
- Displayed student data, anonymously, to demonstrate some progression
- Due to some learners feeling overwhelmed, gave 4 specific questions to the weaker learners to focus on
- 30 minutes for videos, 20 minutes for assessment questions
- Expressed that half term would give them an extra week to look at TikTok videos at home

Week 5 intervention

- 25 minutes to watch videos
- Gave 4 specific questions to the weaker learners to focus on
- Provided a prompt/support sheet, that gave ordered instructions and required formula
- 25 minutes to complete assessment questions

Week 6 intervention

- Taught first 4 questions from assessment paper on IWB
- 25 minutes to watch videos
- Gave 4 specific questions to the weaker learners to focus on
- Provided a prompt/support sheet, that gave ordered instructions and required formula
- 25 minutes to complete assessment questions

Week 7 intervention

- Taught 6 of the assessment questions on the IWB
- 15 minutes to use the TikTok videos to consolidate the information
- Gave 4 specific questions to the weaker learners to focus on
- Verbal prompts for students
- 20 minutes to complete assessment

Week 8 intervention

- Taught 5 questions on IWB
- 25 minutes on TikTok videos to consolidate what had been taught
- Gave 4 specific questions to the weaker learners to focus on
- Provided a prompt/support sheet, that gave ordered instructions and required formula
- 20 minutes to complete assessment

Final Assessment

- 25 minutes provided – students completed under exam conditions

Results

To give a comprehensive breakdown of my results. I have broken these into 4 strands that I will now discuss and highlight key features.

Results for all students

All results are percentage points

- IA to 1 - It is evident that the majority of students improved their score in week 1 (average change +20%), this corresponds to a worked shadow paper provided to the learners as opposed to no support for the initial assessment.
- 1 to 2 – results dip dramatically (-13%) as students are left to work independently in class.
- 4 to 5 – displays a marked improvement (+15%) which could correlate with the re-introduction of a support sheet.
- 8 to FA – displays a drop in average percentage score (-17%) this due to all support removed for the final assessment and the need for all learners to work independently.

However, as seen from the raw scores below, the attendance to the action research project lessons was haphazard and many missing weeks prevented 5 change calculations for large numbers of students. This data is not comparable to all the data as it is based on lower ability learners who have not necessarily completed both the initial and final assessment.

Figure 18 on the following page shows my scores for the entire project. Please note I have included those that have not done the initial and final assessment.

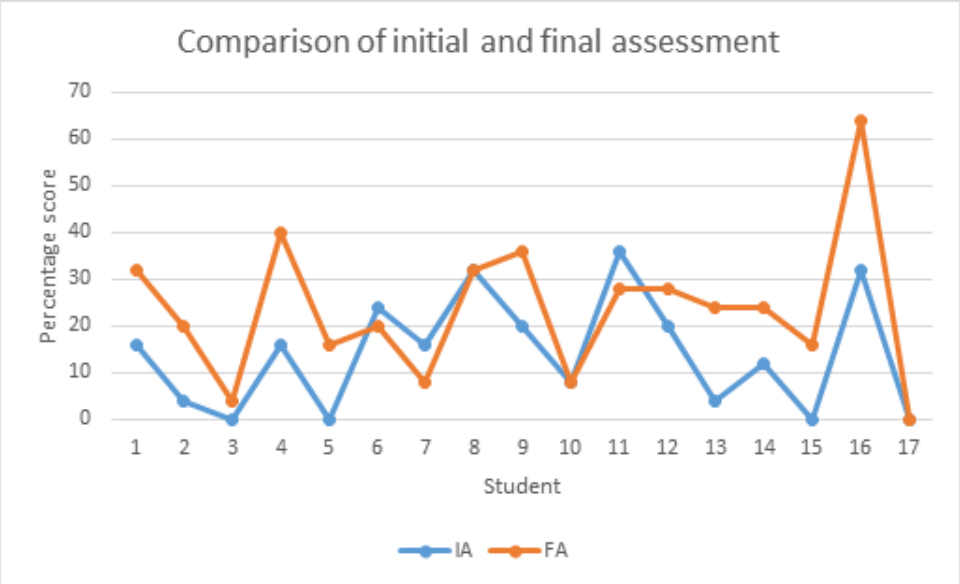
Figure 16 –Entire data set

	IA	1	2	3	4	5	6	7	8	FA	Average pp	Min pp	Max pp	Range pp	Range IA to FA pp	IA to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to FA
student 1		20					64				42	20	64	44	0			-	-	-			-	-
student 2	16	68	24	50	29	48	68	29	25	32	39	16	68	52	16	52	-44	26	-21	19	20	-39	-4	7
student 3	4	28	19	0	10		32		32	20	18	0	32	32	16	24	-9	-19	10					-12
student 4	0	36	19	0	5	32			25	4	15	0	36	36	4	36	-17	-19	5	27		-		-21
student 5		44	90	4		100	86				65	4	100	96	0		46	-86			-14		-	-
student 6			24		5			7	29	8	14	5	29	24	8	-					-		21	-21
student 7	4	24		4							11	4	24	20	-4	20				-	-	-	-	-
student 8	4	40		8			25				19	4	40	36	-4	36							-	-
student 9		40		13	10	28		39			26	10	40	30	0				-3	18				-
student 10	12	0		4		0	25	43	36		17	0	43	43	-12	-12	-			-	25	18	-7	
student 11	16		67	71	33	96	61	75	96	40	62	16	96	80	24			4	-38	63	-35	14	21	-56
student 12	0	68	29		24	64	18	68	54	16	38	0	68	68	16	68	-39			40	-46	50	-14	-38
student 13		0			10		54	43	75	12	32	0	75	75	12	-	-	-				-11	32	-63
student 14		40			10	20					23	10	40	30	0					10		-	-	-
student 15	4			8	0						4	0	8	8	-4		-		-8	-	-	-	-	-
student 16	24	56	33	8	24	28	57	36	14	20	30	8	57	49	-4	32	-23	-25	15	4	29	-21	-21	6
student 17	16	52	24	54	29	48	50			8	35	8	54	46	-8	36	-28	30	-26	19	2			
student 18	32		29	0	57	64	71	89	64	32	49	0	89	89	0			-29	57	7	7	18	-25	-32
student 19			33	42	48	56	75		57	32	49	32	75	43	32	-		8	6	8	19			-25
student 20	12		10	29	24	16					18	10	29	20	-12			20	-5	-8		-	-	-
student 21	20		43	58	71	76	68	89	39		58	20	89	69	-20			15	13	5	-8	21	-50	
student 22			14	33	52	56	54	57	54	52	47	14	57	43	52	-		19	19	4	-2	4	-4	-2
student 23	20	32	24	33	29	72	64	32	46	36	39	20	72	52	16	12	-8	10	-5	43	-8	-32	14	-10
student 24		44	24	33	5		21	29	54	8	27	5	54	49	8		-20	10	-29			7	25	-46
student 25	8	0	29		48	12	32	7	36	8	20	0	48	48	0	-8	29			-36	20	-25	29	-28
student 26	36	88	57	83	48	72	61	96	93	28	66	28	96	68	-8	52	-31	26	-36	24	-11	36	-4	-65
student 27	20		52	58	29	80	54	75	86	28	54	20	86	66	8			6	-30	51	-26	21	11	-58
student 28	4	32	5	29	24	8	4	18	18	24	17	4	32	28	20	28	-27	24	-5	-16	-4	14	-	6
student 29			19	21	10	48	46	18	36	20	27	10	48	38	20	-		2	-11	38	-2	-29	18	-16
student 30	12	52	29	42		56			61	24	39	12	61	49	12	40	-23	13				-		-37
student 31	0	12	10		0		11	14	0	16	8	0	16	16	16	12	-2		-	-		4	-14	16
student 32	32	44	5		29	92	93	68	89	64	57	5	93	88	32	12	-39	-5	29	63	1	-25	21	-25
student 33	0	8	5	0	0	8	4	14	0	0	4	0	14	14	0	8	-3	-5	-	8	-4	11	-14	-
																Av % change	20	-13	1	-3	15	-2	1	1	-17

Results for students who completed both the initial and final assessments

Of the 33 learners in the project,17 of these learners sat both the initial and final assessment. This data is shown in *Figure 19.* Students on average had a 9% increase in their overall score from an average of 14% in their initial assessment to 23% in their final assessment. The vast majority did improve their score during this time. Three of the students performed worse in their final assessment. In fact, they dropped by an average of 6.6%. For the 11 students who made progress, their average percentage rose by 16.4%.

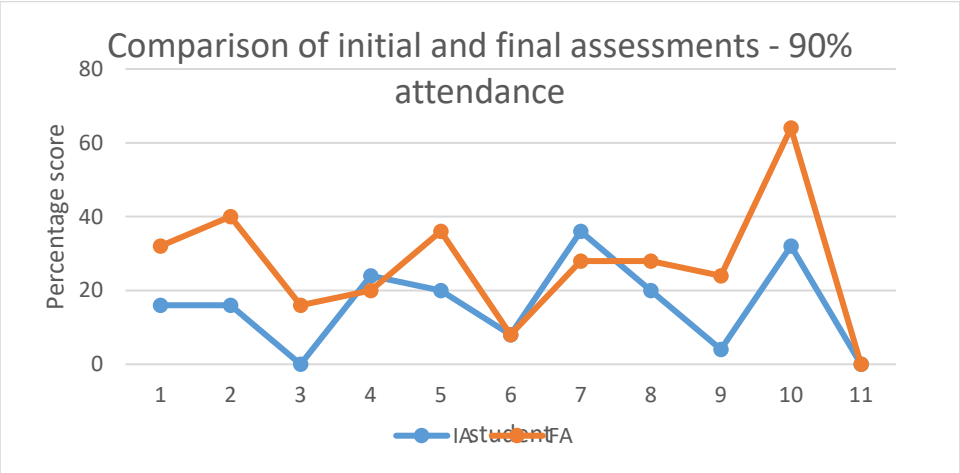
Figure 17-Individual student progress across the intervention



Results for students who completed both the initial and final assessments and had at least 90% attendance

When considering attendance,11 of the students attended 90% or more of the action research project. This is shown in *Figure 18* below. This highlights that attendance plays a significant role in achieving as these students had an average percentage increase of 11%. Of these students who performed worse in their final assessment their average percentage drop was 4%. Conversely, those who made progress had an average percentage increase of 19%

Figure 18 – Comparision of students taking into account attendance



Analysis by topic for those who completed the initial and final assessment

The table below shows how students performed relative to each topic (*Table 5*). This is data for the 17 students that completed both the initial and final assessment. We can see that FMP and area show the most progress during the course of the intervention, with improvements being made with percentages and compound measure. In maths involving algebra and proportion, the learners have not developed their skills. It is important to note that these questions were the more complex A03 questions, and a weaker cohort of learners may not have been secure enough in the foundation knowledge of these topics. I advised the weaker learners to focus on the easier topics and so many did not give these topics due attention.

Table 5 – Showing how average percentage scores vs each topic

Topic	Negative progress	Maintained zero score	Positive progress	Maintained non zero score
FMP	18%	18%	41%	23%
Percentages	0%	30%	35%	35%
Area	18%	23%	41%	18%
Linear Equations	6%	88%	6%	0%
Situations using Algebra	6%	94%	0%	0%
Proportion	6%	88%	6%	0%
Compound Measure	6%	35%	35%	24%

Limitations

Attendance and punctuality have been a substantial issue during the project. The vast majority of learners did not watch the videos as homework and hence used the beginning of the lesson to ‘catch up.’ If they were not punctual to lessons, they had little time to follow the videos. Numerous learners were absent with Covid-19 related issues. The videos were snappy, but too fast paced for a number of learners. They were however encouraged to pause, and rewind each video as needed. From the outset, it was clear that there was a lack of student participation in completing the required work in their own time and this alongside poor attendance, particularly in the weakest classes, hindered progress. Therefore, as a group, we decided that catching up missing weeks would not be viable.

The intervention took much longer to complete in the lesson than anticipated, mainly due to the lack of independent study by each learner; due to this we adapted our methodology. The approach was modified part way through the study, this was allowing time in the session to show the TikTok videos. This was due to learners showing a concerning decrease in engagement with the flipped learning element of the intervention. This reluctance could be attributed to the repetitive nature of the intervention and could perhaps have been alleviated by a less concentrated approach, potentially utilising this innovative mastery method of delivery less frequently, over a longer period.

During our project, we did not have a control group across the ARG, therefore this can provide uncertainty on whether this was natural progress for the year or the introduction of our intervention.

Another pertinent point to bear in mind was that the videos themselves took a while to design, create, record and upload. Not only was it creating a succinct explanation of the maths that was the issue, but also it was a steep learning curve to use the platform and initially took at least two hours to produce each one, with at least 16 made by *each* member of the project.

Conclusions & Recommendations

The use of TikTok style intervention with GCSE maths resit learners is a multi-faceted issue and it is hoped that this study will give some small insight into some of the benefits into this form of intervention.

It can be quite time consuming to become able to create effective TikTok videos along with behind the scenes planning in terms of question selection and an ability to succinctly explain complicated ideas. Some students felt the videos were too long and struggled to follow the more challenging questions. Knowing what we do now we would suggest that the questions selected should be shorter so that the videos will be slicker and therefore more effective.

However, this relatively small-scale study supports the notion that heightened engagement positively impacts outcomes for learners. It is best practice to ensure that all learners are aware of progress made towards the required mark in order to achieve their GCSE maths grade. Given the evidence of such a relationship between engagement and achievement in addition to regular assessment at topic level, the sharing of engagement data could prove to be positive whilst encouraging learners to build the resilience required to support their confidence in the subject.

Confidence does not always correlate with achievement, and it is vital that learners understand this. Further studies of a similar kind with a particular focus on the attributes and impacts of growth and fixed mindsets would work to identify the reasons for this and to explore the strategies with which it can be overcome.

We felt that at times there was too much information to comprehend in a relatively brief time. Students were on occasion weary of the process, especially after a number of weeks. If we were to create these again, we would try to build up the questions in difficulty in order to boost the learners' confidence throughout the project. We further found that this project highlighted the rampant resistance exhibited by our learners completing independent study at home. The A03 questions in the topics chosen were demanding, especially for learners whose highest GCSE maths qualifications were below a grade 3.

From the perspective of the FE teacher it is important to keep the lessons fast paced and to the point. This is even more pertinent as students have had two years of disrupted education, which has negatively exacerbated their attention spans and concentration levels. The TikTok style videos are extremely useful and can be implemented in several ways in the classroom, for flipped learning and independent study, and also provide a unique way of learning to what the student has experienced so far in their learner journey. We would like to extend the activity further if learners were disposed to do so, by encouraging them to create their own short videos on topics learnt, thus by teaching others it would enable them to develop further their mastery skills and conceptual understanding. Furthermore, this could give them more ownership of their learning tools which would encourage greater engagement with flipped learning.

In conclusion, we found that our intervention helped the students to make considerable progress. The data analysis shows a level of ability was not a barrier to accessing and achieving with this learning tool. What the students' survey highlighted was the positive impact the TikTok videos had with the learners. They felt they were broken into manageable sections, succinct and to the point. The overall outcome was that incorporating a technology mastery approach within an FE GCSE Maths provision can have numerous advantages, but a careful balance must be found to incorporate a model which allows enough flexibility to adapt to meet the needs of each learner.

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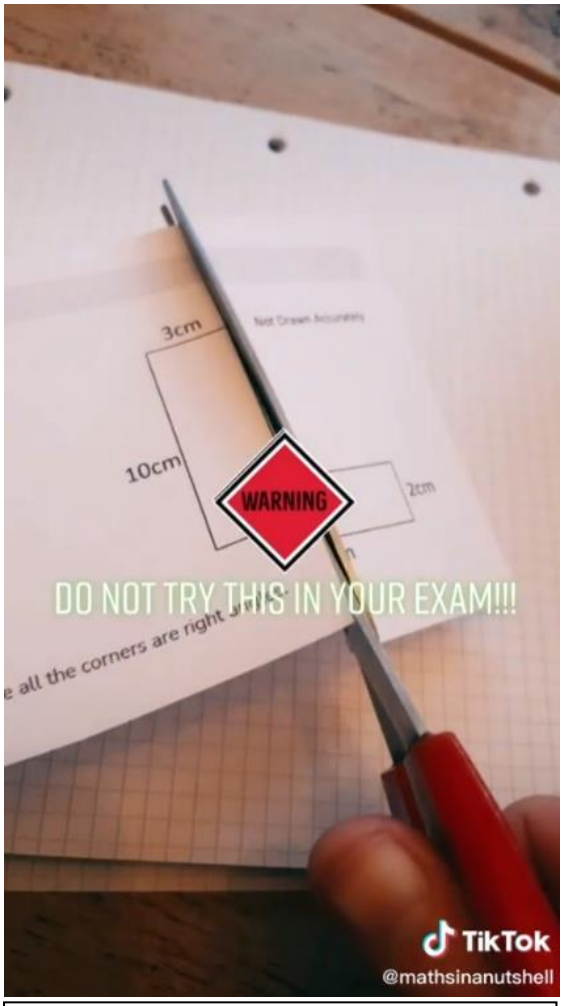
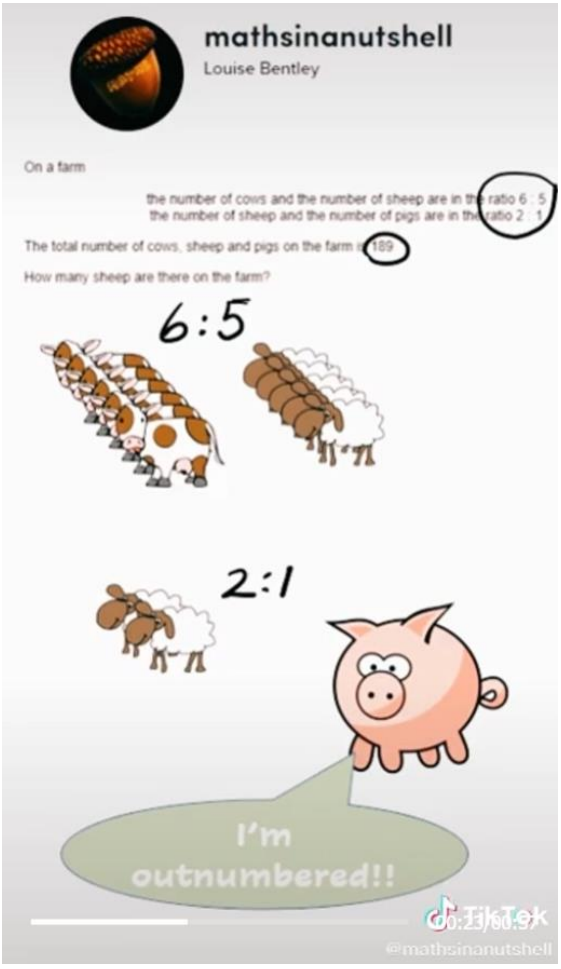
Appendices - Video Examples

Figure 1



Compound area – cutting the shape with scissors to demonstrate two rectangles that make up the shape.

Figure 2

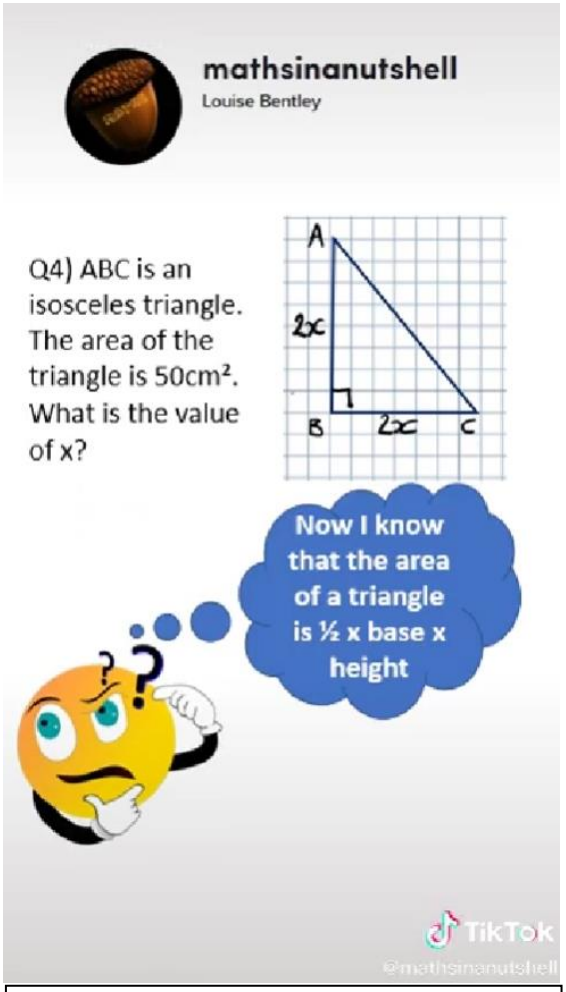


Ratio - with cartoon characters to help visualise the different sections in the question.

Figure 3

Linear Equations - where the student needs to assign ‘x’ to one component in the question, then form a linear equation.

Figure 4



Linear Equations - relating the question to something the student already knows and then forming a linear equation to solve for x.