



**CENTRES FOR
EXCELLENCE IN MATHS**



How can a set curriculum increase the Motivation, Engagement and Achievement of GCSE maths resit learners in FE Colleges?

Mamta Arvind, Jessica Margiotta, Jonathan Diamond

OUR PARTNERS



FUNDED BY



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

About CfEM

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

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

Summary

This action research project is primarily concerned with raising the motivation and engagement levels of GCSE maths resit learners by implementing a set scheme of work and using a set of resources. We have chosen this topic as low motivation in maths is an ongoing challenge faced across FE colleges, owing to experiences of underachievement at secondary school which negatively affects learners' self-efficacy. The scheme of work chosen was the 'Focus 4' resources from the website MathsBox, which are targeted materials for those working to achieve a Grade 4. Furthermore, as online resources, we also felt that they would help form an innovative blended approach that would equally be suitable for remote delivery as necessitated by Covid-19 and the subsequent college closures. Alongside our primary goal of increasing motivation and engagement levels, we had a series of subsidiary research objectives based around achievement and determining the value of technology, which were also investigated during our data collection.

In this project, we used a mixed method approach of both quantitative and qualitative data, with nine staff participants across four colleges in our network (Leeds City College, Shipley College, Calderdale College and Leeds College of Building), and some 166 learners involved in our data collection set. We compiled data using an initial survey for students, both teacher and student interviews, and an end point survey for learners, in order to capture whether there were any shifts in the learners' levels of motivation and engagement as the project progressed. Our staff participants also provided a reflection at the end of our project to substantiate our data further.

We found the trial of the Focus 4 resources to be an overall success, recording positive feedback from both the students and teachers regarding the materials. Indeed, during the student interviews, 81% of learners gave positive reviews of the resources, with many learners consistently referring to them as "useful" or "helpful". It became apparent that the learners responded to the retrieval style of the resources, which covered multiple topics, as this boosted the learners' perception of their progress when they were able to correctly answer questions from a range of topics. This links well with research conducted for our literature review, which postulates the importance of short term goals in maintaining motivation.

Likewise, all of the 9 participating teachers commended the Focus 4 resources as a scheme of work, reporting that the learners could see the value in the resources and understood why they were working on them. Furthermore, they applauded the flexibility offered by the resources; they can be used as a starter, plenary or flipped resource, as well as for differentiation and personalisation.

Finally, as part of this action research, we also confirmed the importance of contextualisation upon motivation and engagement in Maths. In our teacher interviews, the most commonly cited reason for this (5/9 teachers) was that contextualisation helps learners realise why maths as a subject is important and helps combat the rhetoric of 'why do I need to know this?' We also found that contextual maths and use of real life examples help to make certain topics less abstract, and thus the maths becomes more accessible to learners. This finding will help us plan for our future provision, as we recommend that vocational teams and maths teams work together when creating schemes of learning.

Contents

Background	5
Introduction	5
College goals	5
Research Aim	5
Research objectives	6
Literature Review	7
Introduction	7
Existing Research	7
The role of a teacher	8
Teaching approach: routine versus variety.....	8
Contextualising tasks within real life examples	8
Feedback and praise	9
Open-ended tasks	9
Importance of self-efficacy	10
Gaps and limitations in the literature	10
Conclusion.....	11
Methods.....	12
Overview	12
Data collection methods	12
Thematic coding.....	13
Results and Findings.....	14
Participants	14
Motivation and engagement with Focus 4 resources.....	14
Barriers to learning	17
Confidence/achievement.....	18
Contextualisation	19
Conclusions and Recommendations	21
Conclusions	21
Learner engagement.....	21
Teacher Advocacy	21
Targeted at Grade 4	21
Recommendations	21
References	23
Appendices.....	25

Background

Introduction

Leeds City College is one of the largest further education institutions in the country with more than 20,000 students. We have 4000 GCSE Mathematics enrolments in the academic year 20/21 and this figure has grown as the college has grown. Our actively participating network partners, Calderdale College, Shipley College and Leeds College of Building, have comparatively small cohorts, but are largely similar to us regarding maths policy and attainment figures.

Our maths policy is simple: the learner is at the heart of the decision. Our GCSE Mathematics results have steadily increased over the previous 3 years from below 13% for grades 4-9 to 21% for grades 4-9. Being a participant in the Centres for Excellence in Mathematics has no doubt aided this success as the opportunities afforded to maths teachers to network, learn, share, grow and access high quality and FE relevant CPD, has been to no end. In house support, alongside expert external guidance has also had a direct impact on our results.

College goals

At Leeds City College, our values put students first and are at the heart of everything we do. We strive to be an outstanding and market-led further education college that delivers excellence. To achieve this, our vision, mission, and values guide us as we continue to improve upon and expand our offering.

Our vision is, “to be a UK leader in vocational and academic education.” It’s not enough for us to provide vocational and academic education; we push ourselves to exceed the expectations of all of our stakeholders while providing our students with the best experience possible. By delivering excellence, we continue to work towards our vision to be a UK leader in vocational and academic education.

Research Aim

Across the FE sector, fostering levels of engagement in GCSE maths is one of the largest challenges we face as practitioners, owing to the fact that learners generally arrive at College notably demotivated in maths due to negative experiences in the past. Our action research project was therefore based around raising our learners’ motivation and engagement levels, and in turn, improving their rate of achievement. In previous years, we practiced growth mindset during our induction periods, but we wanted to explore this further by trialling the use of a set curriculum amongst our participating cohort.

We decided to use the ‘Focus 4’ resources from the website MathsBox, as these are specifically targeted materials used for consolidation and revision of all topics required to achieve a Grade 4. We also believed that these resources would help form an innovative blended approach that provided alternative learning tools to meet the needs of all learners.

The teachers involved in the project covered 6 key topics per session, meaning that all the 30 topics were able to be covered in 5 sessions. Thus, by completing these 30 ‘Focus Topics’ five times, we set out to develop a positive learning environment with a clear structure, also promoting a can-do attitude by setting short term goals, monitoring progress and recognising success.

Research objectives

(RO1) To look into previous research and literature review to identify if a set Scheme of Learning (SOL) has an impact on motivation, engagement and achievement of learners.

(RO2) To develop an effective curriculum based on Focus 4, 30 Focus Topics aiming for a Grade 4.

(RO3) To deliver and analyse their effectiveness with regard to the improvement of learner motivation and engagement.

(RO4) To design and implement the use of worksheets/google forms based on 15 questions covering 9 key skills and 6 questions on the Focus Topics.

(RO5) To disseminate findings with our network partners and cross college curriculum and make recommendations for future delivery models.

(RO6) To analyse whether the use of a fixed set of resources adds value to learning of mathematics and has an impact on achievement.

Literature Review

Introduction

Across the FE sector, one of the most common concerns that teachers have voiced is about the impact and importance of learner motivation and engagement on the achievement of learners. Maintaining levels of engagement has become increasingly challenging due to the move to online learning as a result of COVID-19, although this has always been an obstacle particularly regarding learners in Further Education colleges.

This has been perpetuated by the Government implementing compulsory education to learners who did not achieve a grade 4 in Maths and English within secondary school. Therefore, students often arrive at FE colleges with very little motivation towards maths due to experiences of failure and underachievement at secondary school, where they have had years of experiences that have shaped their opinions about their low self-efficacy. These experiences can negatively affect student perceptions of education and reduce their motivation to learn in the future, and it can become increasingly difficult for teachers to help students change their beliefs. Therefore, research focused on motivation and engagement in mathematics is particularly important, especially given evidence that links low levels of student engagement with academic underachievement (Martin and Marsh 2006).

We at Leeds City College therefore try to incorporate proven strategies to assist motivation and engagement across our cohort, e.g. by teaching in smaller groups where possible, with personalised help available through our study coaches and attending our ILZs (Independent Learning Zones, where learners work on their personalised goals with the support of a coach). However, as aforementioned, this is still one of our principal obstacles in improving student achievement and attendance, and so we are looking to improve on this topic. As such, we are participating in research around this field, with our own action research project investigating the impact of using a set SOL/resources to help learners achieve a grade 4 in GCSE Maths.

Keywords: motivation, engagement, self-efficacy, confidence, achievement, GCSE maths resit, FE, goal setting, secondary school, mastery, misconceptions and effective curriculum

Existing Research

Although there is a significant amount of research that emphasises the relationship between motivation, engagement and achievement of mathematics in a classroom setting, the majority of the work focuses on students in middle or secondary school. There is limited research around the setting of Further Education, and the nuances and implications that accompany this, so this is an area which requires further investigation. Nevertheless, we have managed to find a useful article that delves into GCSE Maths resit students in the FE sector which we will later reference in this review. The existing research around this topic often looks into mathematics self-efficacy, the teacher's influence, maths anxiety, self determination, and various frameworks and theories behind student motivation and engagement. Our literature review covers a selection of more than 12 articles that are overall pertinent to our project. We have observed some common themes across the various articles, which we will detail and discuss below.

The role of a teacher

Throughout the research on this subject there seems to be a confident consensus that the teacher plays an integral role in aiding motivation and engagement in maths (Bobis et al 2011; Kirby et al 2015; Sullivan et al 2004; etc), though there is some difference of opinion regarding which methods are the most successful at promoting better motivation.

Teaching approach: routine versus variety

Durksen et al suggest that the principal way a teacher can yield more progress with engagement and motivation is to implement effective classroom organisation (Durksen, Way, Anderson, Skilling & Martin 2017). Their study states that a student's motivation in mathematics—their willingness to try different solutions and persist—appeared to be best encouraged through a safe and predictable classroom climate. They emphasise the notion of comfort in the classroom; that students should feel secure and in a 'non-threatening' environment, which they propose should be achieved through clear structures, routines and predictability when teaching maths. As part of this tightly structured approach, their results indicated that short time limits were effective at keeping learners engaged with a task, particularly when working in pairs. Therefore, this suggests that a teacher should implement a carefully structured space where learners can build self-confidence and practice set tasks, so as to nurture self-belief in maths and avoid confusion and panic, which are key in causing disengagement. However, according to research undertaken at Warwick University, this type of routine and predictability restricts learners to a 'comfort zone', whereas the 'growth zone' is where the most effective learning happens (Mackrell and Johnston-Wilder 2020). Bobis et al also subverts the priority of consistency and routine, instead arguing that using varied approaches better promotes motivation and engagement, because a varied style and mix of methods accommodates for a range of personalities, work rates and learning preferences (Bobis et al in Brahier and Speer, 2011). Their chapter continues with the notion that consistently using the same teaching approach advantages some students and disadvantages others according to the compatibility of the approach with their learning preferences, and so asserts that the role of the teacher is to implement numerous modes of task and information delivery (such as verbal explanation, visual presentation, multimedia, online resources, models and simulations, using calculators and other equipment etc), as well as variety in assessment strategies.

Contextualising tasks within real life examples

Another way that is considered to be an important teaching method to improve learner motivation and engagement is to draw upon real life examples; whether contextualising the work in students' interests or framing how the task will be applicable in their future studies or career. Indeed, Durksen et al refer to this as 'mastery orientation' (2017), which they identified as a common theme in their research, whereby the teachers provided real-life connections and explained the value of the learning. This positive motivation proved successful at getting students involved and engaged with a skill or task, because they consider it as important to know later in life. In accordance with this, Bobis et al also commend the effectiveness of contextualising maths work within the student's life as a way of increasing engagement. They propose that: "embedding mathematical learning in real and relevant contexts, particularly contexts that let students use personal expertise, can increase their sense of control and self-worth" (2011), which indicates that it not only improves engagement with a topic, but also may improve the student's own perception of

their self-efficacy.

Feedback and praise

The teacher's role of giving feedback and praise is also widely accepted as being an essential factor at generating positive engagement and motivation amongst students. It is clear that learners lacking motivation in maths require support rather than punishment (Macleod 2006), which correlates with research demonstrating that "the most successful classroom management approaches were humanistic strategies, and the least effective being the most authoritarian" (Reupert and Woodcock 2010). In Brahier and Speer's book *'Motivation and Disposition: Pathways to Learning Mathematics'*, a student quotation aptly captures the link between feedback, improvement and confidence:

"I like the way my Year 8 mathematics teacher doesn't just mark my work right or wrong—she actually explains what I need to do to improve. She gives me confidence so I know I can do this!"

Here, it is apparent that useful feedback which focuses on enhancing work and progressing is intrinsically linked with confidence and self esteem, as understanding goal progress and *how* to improve on their work makes this seem achievable. This ultimately sustains the student's motivation and improves their work and results. Furthermore, Heshamti et al distinguish 'effort feedback' as particularly valuable for enhancing student engagement (Heshmati, Johnston-Wilder, Sinclair 2018); for example, statements such as "you got it correct because you worked hard and didn't give up" are highly effective as it places emphasis on the importance of effort and growth mindset. They go on to further concur that good feedback and praise can indeed improve self-efficacy (and in turn engagement), though they suggest that positive feedback may be most powerful when directed to students who have worked hard and were successful, rather than those who tend to be generally capable and 'good' at the subject. However, there are some exceptions to this general consensus that teacher feedback and praise can effectively improve engagement. Indeed, Alt (2015) suggests that this is only a surface approach to motivation, and can be linked to 'low quality outcomes of learning'. He proposes that, conversely, intrinsic motivation produces longer lasting internal effects, and so favours the Self-Determination Theory (SDT) for self-motivated and autonomous behaviour.

Open-ended tasks

Another way in which teachers can generate engagement and motivation is to set open-ended tasks and questions to help learners explore mathematical situations using their current knowledge and understanding (Bobis et al 2011). While planning these tasks, teachers need to think carefully and design prompts for learners who would generally stall after one or two solutions and additional prompts for learners who would complete their task quickly so that their learning could be extended.

It is agreed that teachers can easily create open-ended questions by working backwards from a given answer or modifying an existing question (Small 2009; Sullivan and Lilburn 2004), and by posing an additional challenge using either of the above two approaches, teachers can then understand their students' thinking and why they chose a certain strategy. Furthermore, Bobis et al explains that open-ended questions tend to have many solutions and several methods of finding solutions. Doing this opens up opportunities for success, reducing anxiety and giving students more control as they make the decision on using the

best strategy for them. Likewise, problem solving skills are developed further by using open-ended questions and are generally considered less threatening than more challenging tasks as the focus is on process, independence and flexibility instead of necessarily finding a correct answer.

Importance of self-efficacy

There is a clear correlation between student performances and self-efficacy, with a general agreement amongst researchers that when students do not see themselves as competent their achievement is lower (Kirby et al. 2015; Nguyen 2015; Leaper, Farkas, & Brown 2012), which is in accordance with the claim that students with high self-efficacy are more likely to persevere with a given task and continue to work on problems until they are solved or correct (Pajares & Miller, 1994).

However, in spite of the clear connections between self-efficacy and achievement, far less research has been done on the actual learning and teaching approaches which promote self-efficacy in maths classes. One technique that has been proposed however, is that of goal-setting. Oldham proposes that many students with low self-efficacy have difficulty in seeing long term progress and envisioning success, but that promoting interim subgoals allows students to have that more immediate insight to gauge their abilities (Oldham 2018). This echoes the findings of Bandura and Schunk, who propose setting a short term subgoal that students can judge themselves on whilst they work to a larger goal that takes a longer time to achieve. They claim that subgoals “provide immediate incentives and guides for performance, whereas distal goals are too far removed in time to direct what one does in the here and now” (Bandura & Schunk, 1981). Effective goal setting can further improve learner confidence if the goals are challenging but attainable, as this creates a perception of progress which enhances self-efficacy and encourages learners to continue working hard (Schunk, 1995). Heshmati et al (ibid) similarly suggest that students progress better if they are set short term SMART targets, as this gives the learner the means to aid their success and track their progress.

Another notable point in this research was the value of vicarious experiences; that even just by viewing a similar peer successfully completing a task can encourage others to follow and tackle the task (Warwick, 2008). However, this might only be true when they view their peer as a similar other; if the learner feels that they are inferior to their peer, there is a chance that the self-efficacy effect may be undermined (Heshmati, Johnston-Wilder & Sinclair 2018).

Gaps and limitations in the literature

Overall, it is evident that both raising a learner’s self-efficacy and the impact of the teacher are the principal factors for increasing engagement, however the field would benefit from more research into how to do this efficiently.

As outlined above, there are gaps in the research into self-efficacy, as though there is ample evidence between self-efficacy and achievement, studies now need to investigate and analyse the mediating factors that affect self-efficacy itself, so we can better understand how to improve this. Indeed, because self-efficacy is an internal construct created by each learner, it is important to determine ways for external agents, like teachers, to influence positive efficacy and goal beliefs (Oldham 2018).

Furthermore, many of the above cited sources largely pertain to secondary schools, with data somewhat lacking in regard to the impact an FE environment has on motivation and engagement, so often the different contexts make the findings difficult to apply to our own cohort and research. There are also other limitations to the literature we have analysed. For example, Durksen et al's article appears very useful and informative in their findings about strict classroom routine and comfort to enhance motivation; however, their chosen participants for their research were six teachers (upper primary and secondary) that taught students with higher-than-average levels of motivation and engagement in mathematics. The use of these participants, who were already proving to be well engaged, may therefore lead to limited results as the motivation levels towards maths was at a high starting point originally, and the results consequently show little evidence of negative engagement. As such it is difficult to assess the effectiveness of the strategies used for learners who are more resistant or who have very low confidence, such as some of those in our own study.

Conclusion

In this literature review we have examined the different factors that can increase learners' motivation and engagement towards maths, and the ways that this can be improved in order to ultimately improve their achievement. For our research question, the role of the teacher is of particular relevance, as is the literature regarding learners' response to varied lesson deliveries. This links quite closely with our project, in which we are investigating whether routinely using a set scheme of resources in each maths session will impact learner engagement and motivation, and whether this has an impact on achievement. Furthermore, the conflicting views around the idea of using routine and structure in lessons will help shape some of our questioning in our data collection phase; we will now seek to better understand the learners' opinions towards the consistent use of set resources and determine if it is the routine that they like/ dislike, or simply the content of the resources themselves. Additionally, it is clear that the learners' own self-efficacy is a major barrier to learning and progression with maths, but one key take away from the research was that establishing short subgoals and targets helps to improve self-efficacy, due to the perception of progress. Another recommendation for future practice from the literature review phase of this research is that of 'effort feedback' - the emphasis on praising effort when giving feedback, in order to promote the concept that continued work and engagement yields results. Ultimately, understanding the different contributors towards engagement in maths is extremely significant, as engagement is intrinsically linked to achievement and results, and the research around this field is particularly important for us as a Further Education college, where students generally begin with poor engagement towards maths due to negative experiences of failure at secondary school.

Methods

Overview

Our research project used a mixed method approach utilising both quantitative and qualitative data. We had nine teacher participants across four colleges in our network (Leeds City College, Shipley College, Calderdale and Leeds College of Building), with 166 learners involved in our data collection set, though we did experience a decline in learner responses towards the end of the project. In terms of data collection methods, we decided not to use an observation schedule due to difficulties with observing remotely via Google Meets, where most of our learners opt to turn their cameras off. We therefore decided to compile data using an initial student survey, teacher and student interviews, and an end point student survey for learners, in order to capture whether there were any shifts in the learners' levels of motivation and engagement as the project progressed. Our staff participants also wrote a reflection piece to substantiate our data further. Our students provided consent during the initial survey and were informed about how we would securely and confidentially store their data, confirming that any sharing of data with our network partners for dissemination would be entirely anonymous. We also gained consent during the interview process, in which they stated if they agreed for the interview to be recorded, and whether it should be audio only or visually recorded. The learners were able to withdraw from the study at any point.

Data collection methods

- An **'initial' survey** of students received 166 responses from a total of 166 participating maths students across four colleges in our network (Leeds City College, Shipley College, Calderdale and Leeds College of Building). This survey was created via Google Forms because this is a platform that the learners have regularly used in the course of their online learning for quizzes etc., with a succinct design (8 questions with an approximate completion time of 5 minutes). We used multiple choice or tick box style questions wherever possible, as during previous research projects we found that open ended questions were mostly left blank.
- Nine individual online **teacher interviews** were conducted live using recorded Google Meet sessions. There were 9 open-ended questions that aligned with our research objectives.
- A total of 54 **interviews with students** were conducted online using Google Meet. These 54 learners were randomly chosen by teachers from those who were willing to be interviewed. We asked 9 questions that corresponded with our research objectives. Some questions overlapped with those asked in the teacher interviews, however we rephrased the questions slightly to ensure the learners' understanding, and asked follow up questions to the learners if they had any difficulty answering.
- An **'end-point' survey for students** got 88 responses from a total of 166 learners. All of the 88 students completed the 'initial' survey. This survey was also conducted via Google Form. We considered which research objectives had already been met in the previous data collection points and devised questions accordingly to cover any remaining research objectives.
- **Teacher reflections** were gathered from 7 colleagues via google docs to substantiate our data further.

Thematic coding

For the qualitative data from the interviews and from various survey questions, we thematically coded our results. We did this one question at a time, and used a different tab on Google Sheets for each question for clear organisation.

We simplified each part of the answer from the participants into a condensed summative statement or 'code'. Once we did this for all the responses, we then began to tally and count how many of each code there were. We then were able to clearly see that certain codes had some overlapping or similar qualities, and we were able to group these into thematic codes. We then used a filter to rank the frequencies so that our data was ordered from most common code to the least common code.

This process was helped by transcribing the interviews, as we became very familiar with the data and this certainly helped to facilitate our identification of common strands. The fact that we transcribed the data for the interviews also meant that we had little cleaning to do in terms of correcting typos etc, and we were also able to convert speech into proper English as we went along, e.g. by transcribing the students' "cos" as "because" etc.

Results and Findings

Participants

Of the 166 learners involved, approximately 70% had a Minimum Target Grade (MTG) of a grade 4, and 17% were working towards a grade 3. A small minority of learners were working towards a grade 5, grade 2 and grade 1. This type of baseline data provides an insight to the subsequent findings, so that we can contextualise the overall ability of the learners' we are investigating. From all the data collected, we have identified the below themes to be the most significant findings.

Motivation and engagement with Focus 4 resources

The trial of the Focus 4 resources proved to be a success, being well received by both students and teachers. This opinion became evident in the student interviews, as well as in the teacher interviews, the end point survey and the teacher reflections, as detailed below.

Indeed, during the student interviews, 44 of the 54 students gave positive reviews of Focus 4 resources, with many of the learners commenting that they have been "helpful" and "useful" to their studies. It is significant that these two adjectives were used consistently, as this indicates the actual value and learning that has taken place as a result; as opposed to emptier, more subjective comments such as 'I liked them'. Figure 1 further details other typical responses commending the resources:

Student 5	<i>"they cover everything we need to know"</i>
Student 12	<i>"I find them interesting"</i>
Student 23	<i>"It's been helping a lot. It knuckles down on what needs to be learned, those specific topics. It's definitely helping"</i>
Student 30	<i>"Really useful"</i>
Student 46	<i>"I think they've been good, they've helped me."</i>

Figure 1

Having established this impact on learning, in the end point survey, we wanted to evaluate the specific effect on the learners' motivation levels.

Figure 2

Of the 88 respondents, 55 learners confirmed that they had an increased level of motivation for their maths sessions when they were using the Focus 4 resources. A further 25 learners suggested their motivation had not changed, whilst an additional 6 learners were unsure.

Of those who reported an increased motivation when using the Focus 4 resources, a number of different reasons were provided to explain why they feel this way, which are displayed in Figure 3.

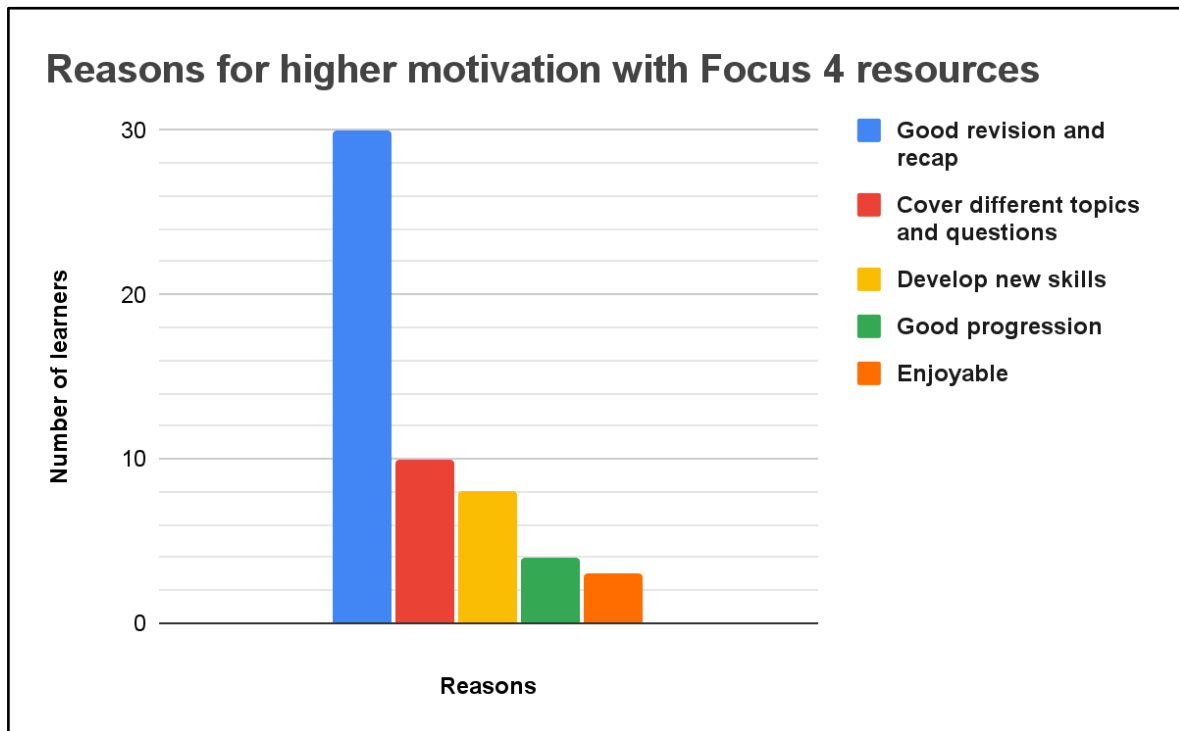


Figure 3

Of those 55 learners who advised that they are more motivated when using the Focus 4 resources, 30 learners explained that this is because the resources serve as effective revision and recapping which keeps different questions “*fresh in your mind*”. These learners detailed that reviewing different topics increased their motivation as displayed in figure 4.

Student 1	<i>“I became more motivated because it was a variety of topics that we recapped or learnt about and it supported us with revision.”</i>
Student 8	<i>“They helped me remember the topics that I had not done in a while.”</i>
Student 17	<i>“The questions are all different so it gave me a chance to do what I felt comfortable doing then challenge myself with the harder ones after.”</i>

Figure 4

The successful use of Focus 4 resources to improve learners’ levels of motivation and engagement is also corroborated by the participating teachers. During their interviews, there was a consensus amongst the 9 teachers that there had been an increase in engagement since starting this project and covering the Focus 4 topics. Similarly, during the staff reflections at the end of our research, every participating staff member advised that they would continue to use this set of resources in their future practice. Figure 5 provides an insight into the teachers’ experience using these resources, observing that Focus 4 was

useful as retrieval practice as well as for initially engaging learners when used at the beginning of the lesson.

Teacher 1	<i>"We mostly used Focus 4 resources as starters; I found this to be rather effective in spiking the interest of the learners at the start of the session. The way in which they are laid out simulated an online assessment (which we had been using), but without the pressures and expectations of an exam. Overall the Focus 4 resources provided a great platform in which to probe gaps in knowledge and give learners a quick set of revision questions every lesson. I know my learners found them very useful and the fact that they were completed every lesson meant they became a routine part of their maths lessons."</i>
Teacher 4	<i>"My learners have engaged well with the Focus 4 resources. We used them as an electronic Microsoft form version which helped push it out to learners during the lockdown phase of our teaching. Some learners struggled with some of the questions but this was to be expected as we had not covered all the topics at the stage of this research. Overall, the learners were happy with the work set through these."</i>
Teacher 5	<i>"The learners have engaged well with the materials. I used the resources for starter tasks, this was during lockdown, so the lessons were all online. This prompted learners to revise the topics that they don't fully understand during their independent online sessions."</i>
Teacher 7	<i>"I think for my group of students the questions might have been a bit higher than their level currently, however they all tried their best and attempted each question. They were focused for the duration of the activity time set (15mins) and then listened and participated in discussing answers afterwards too."</i>

Figure 5

Only 10 of the 54 students had negative opinions about the Focus 4 resources, with some having issues with the google form versions that we created for lockdown purposes, such as the image quality being low, or struggling to draw when required. This is an important distinction, as it was not the materials themselves with which they had an issue, but rather the formatting of the google form versions that we had created so that we could easily use the resources even in periods of lockdown and remote learning. As the project spanned the course of the pandemic, we were required to make provisions like these and so could not always use the resources as originally planned; however, that the students still engaged well with the resources despite the context of remote learning speaks volumes. A smaller minority of the learners (as indicated by Teacher 7 in Figure 5) did find the questions to be too challenging, owing to their lower MTG and work level.

Barriers to learning

Further to the research conducted in our literature review, we also wanted to ascertain our own students' perspective regarding what might stop their peers or themselves from progressing in maths. During the student interviews, the students identified a number of possible barriers to learning that can be divided into 9 main categories as shown in Figure 6.

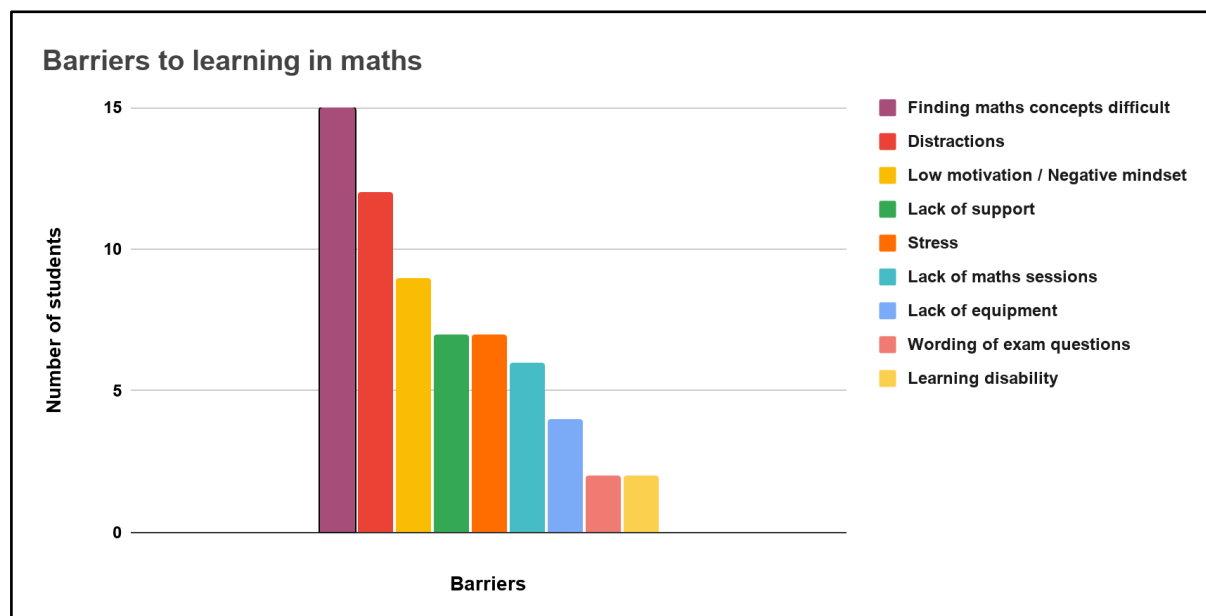


Figure 6

The most common barrier proposed by 15 of the 54 learners was difficulty understanding a certain method and struggling to understand various maths concepts. The students identified the second greatest barrier to learning in maths as distractions (for both in college and remote learning) such as *“when people are shouting out”*, *“distractions from family members and outside”* and *“people messing about outside the classroom.”*

We then asked the teachers in their respective interviews what they identify to be the most common barriers to learning, and more importantly, how they try to tackle these barriers. The teachers identified that barriers to learning can range from: SEND related issues, difficulty accessing technology, low self-efficacy, issues in home life, work requirements, carer duties, and low attendance. Due to this range of possible barriers, a variety of methods were suggested to try and overcome these. Of the 9 teachers interviewed, 4 suggested personalising their teaching and catering to the individual by using differentiation strategies, while 4 teachers also stated that they try to remove accessibility barriers by using devices such as screen readers, and making typographic considerations. Finally, another 3 teachers emphasised that it is important to maintain a positive teacher-student relationship in which they can seek the learners' input and ask them for advice on how they would like things to be done.

Teacher 1	<i>"I encourage learners to tell me how these things can be improved. This year this has mainly been through online polls, surveys and getting them to leave comments in the chat."</i>
Teacher 3	<i>"I speak to them, ask if I'm doing something wrong, how could I help you, is there anything I could do?"</i>
Teacher 5	<i>"If you have a good relationship you can remove a lot of ideas straight away, such as confrontation, refusal to do work, refusal to follow instructions. Once you get rid of those barriers you can have the learners sitting down and learning".</i>

Figure 7

Confidence/achievement

In order to evaluate the impact of the Focus 4 resources on the learners' confidence at answering GCSE maths exam questions, during the end point survey we gave a number of example questions from a range of maths topics and asked the learners to evaluate how confident they would feel in answering each question if it came up in an exam.

For each question, the learners were given a ranking scale from which they could choose one option: "Very confident (I know how to answer this question)" / "Quite confident (I have some idea of how to answer this question)" / "Not very confident (my answer would be a guess)" / "Not confident at all (I would not attempt this question)". Figure 8 below captures the overall confidence percentages towards each topic question.

Topic	Confidence levels
Statistics - two way table	81% confident
Proportion - recipe	77% confident
Algebra - expand and simplify	76% confident
Fractions - lowest form	66% confident
Trigonometry - missing side	53% confident
Geometry - plans and elevations	51% confident
Transformations - rotation	50% confident
Angles - finding angles in a triangle	47% confident

Figure 8

As might be expected, there is some variation depending on each topic, however the overall response is fairly confident, with just one question (angles) receiving a confidence rate below 50%. Across all 8 questions, the average response is 62% of learners feeling either quite confident or very confident, having at least some idea of how to tackle the question. It is also interesting to note that the 'not confident at all' option is the least common choice for all of the questions except for just 2 (angles and plans and elevations).

This investigation into the students' confidence links back to our literature review, in which Pajares & Miller suggest that students with high self-efficacy are more likely to persevere with a given task and continue to go on to achieve their grade. It is therefore significant that the surveyed learners felt overall confident when faced with the potential exam questions, serving as an indicator for future achievement. This information also helps us glean an insight into the possible impact on the cohort's achievement, something for which we currently have limited data due to the ongoing Teacher Assessed Grades process; we hope to be able to comment on this further over the next few months once we have received results, however the confidence levels in answering potential topics is a useful interim gauge.

Contextualisation

Further to existing research that postulates contextualisation of maths tasks within real life situations improves learner motivation and engagement, we wanted to investigate this concept with our participating teachers. Like with the prevailing opinion amongst researchers, there was a definite consensus across our 9 teacher interviewees that contextualisation of maths is very important for motivation in GCSE maths. Figure 9 explores their reasons for this belief.

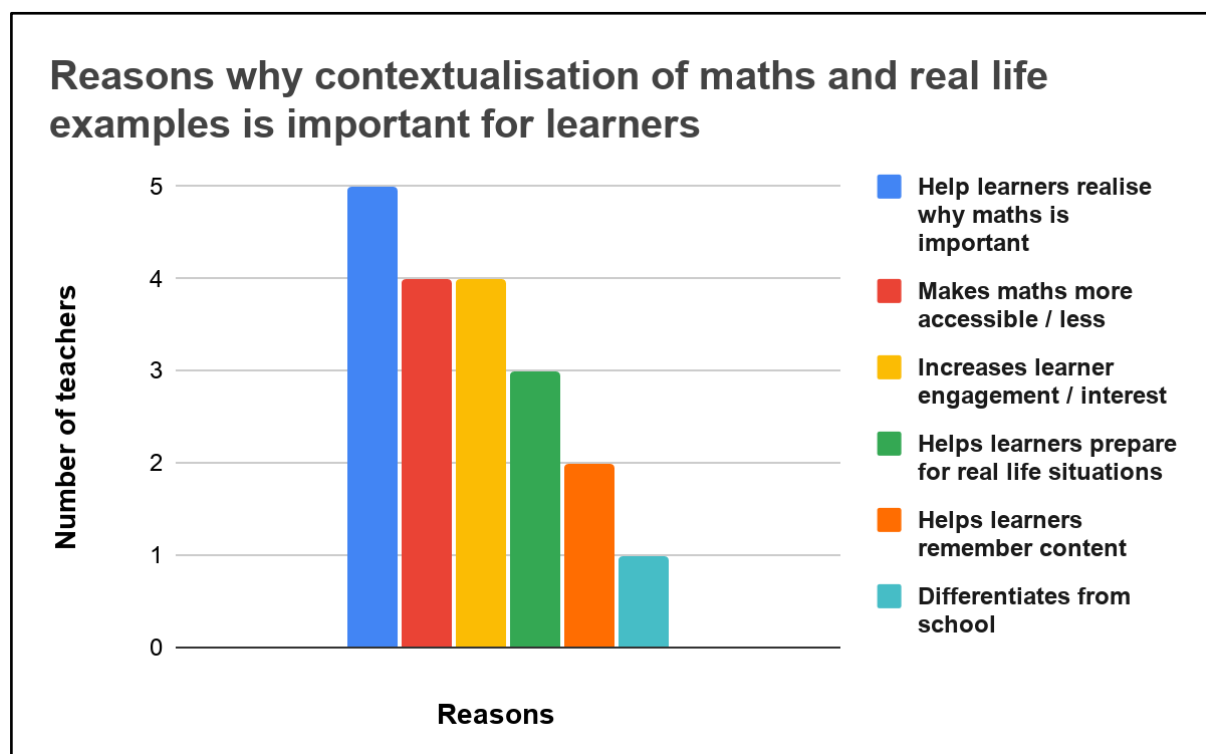


Figure 9

The most commonly cited reason (5/9 teachers) was that contextualisation helps learners realise why maths as a subject is important and helps combat the rhetoric of 'why do I need to know this?' The second and third most common were that contextual maths and use of real life examples helps to make certain topics less abstract, and thus the maths becomes more accessible to learners, and contextualisation helps to increase learner engagement as the content is more interesting to them. A typical quote around these points is as follows:

“This engages learners a lot more when they see where something is used and how it relates to them. My students do very practical subjects so when the two knowledge sets line up it really helps with engagement”.

A further 3 teachers also suggested this was important as it helps prepare learners for real life, and thus embed real life scenarios that students are likely to encounter, e.g. relating to mobile phone contracts or railcard discounts. One teacher commented on why FE learners in particular are receptive to contextualisation:

“I have found that the importance of real life examples is more prevalent in a further education setting as the learners are more concerned about their future”.

Two teachers also suggested that contextualising maths into their vocational course or into real life helps make the content more memorable for the learners, whilst one teacher also suggested this strategy helps distinguish college from school, where contextualisation is less common.

Conclusions and Recommendations

Conclusions

Our project's main aim was to raise learners' motivation and engagement levels, and in turn, improve their rate of achievement by using 'Focus 4' resources from the website Mathsbox.

Learner engagement

The use of the 'Focus 4' resources as part of a set scheme of work has had a significant impact on the cohort's motivation and engagement towards their GCSE Maths lessons. One way this is apparent to us is that the majority of students actively engaged with these resources despite most learners identifying that they do not find maths as a subject engaging. Indeed, in our initial survey, 54% of learners answered that they do not find maths interesting. It is therefore an indicator of the project's success that 72% of the same students suggested that they enjoyed working on the Focus 4 materials, with a further 81% finding them useful or helpful. Furthermore, where attendance data was available, the learners participating in our action research generally had a higher attendance rate than the college average, which further suggests that the learners were more motivated than their peers who were not involved in the trial.

Teacher Advocacy

It is also important to note that the resources were similarly well received by the involved teachers, of whom all stated their intent to continue to use the resources as a scheme of work after the project's completion. This consensus is a clear indicator of the impact and value of these resources, not only at enhancing learner engagement, but also as a tool to facilitate teacher planning. From our teachers' reflections, it is clear that they found the Focus 4 materials useful; they cited the flexibility of these resources as a formative assessment tool, which due to their non-prescriptive design can be used as either a starter, plenary or as a flipped learning resource, as well as being able to be used for stretch and challenge, or even for differentiation purposes. This ultimately aids teachers with their planning and allows for them to optimise their time.

Targeted at Grade 4

The resources are specifically targeted at those aiming for a grade 4, so it is perhaps unsurprising that some learners with a lower minimum target grade than a grade 4 reported that they found some of the questions to be too challenging. In the participating cohort, 23% of learners stated that they are working towards a grade lower than a grade 4, meaning that they could not always access the content without teacher scaffolding. These learners are the small minority that found the resources unhelpful, confirming that the resources are best used with learners with grade 4 minimum target grades unless for stretch and challenge.

Recommendations

- Select the appropriate GCSE Focus Tasks

Having established the potential of utilising these resources, teachers should take care to select the appropriate Focus task according to the minimum target grade of their learners so that students can master the required topics needed to achieve that grade. Indeed, MathsBox offers Focus topics and questions for each grade from 1-9, and so the teacher has the ability to cater to the individual and personalise the learners' journey. Furthermore,

we recommend that the Focus 4 resources are paired with the Focus 5 resources for stretch and challenge purposes.

- Use for exam preparation

We propose that we run a 10 week programme ahead of an exam series (such as the November exams) in which we again trial the Focus 4 resources. This would allow us to directly record the impact on the learners' achievement and gain empirical data that we are lacking this year. If the programme has a notable impact on achievement (and not just engagement and motivation), we would then look to repeat this ahead of the June exam series.

- Contextualisation

The leading researchers in this field, as well as our own maths teachers, have all accentuated the importance of contextualising maths to further improve learners' motivation and engagement levels. Teachers should therefore ensure that they use real life examples when teaching maths, as well as relating to the learners' vocational courses. There should be a whole college approach to create a scheme of learning that embeds contextualisation in both maths and vocational areas. To help achieve this, we suggest that during planning for the next academic year, both maths and vocational team members sit together and work on creating their scheme of learning, proposing effective examples that tie in maths and vocational areas together.

References

Alt, D. 2015. "College Students' Academic Motivation, Media Engagement & Fear of Missing Out". *Computers in Human Behavior*, 49(2015): 111–

119. <http://dx.doi.org/10.1016/j.chb.2015.02.057>

Bandura, A., & Schunk, D. (1981). Cultivating competence, self-efficacy, and intrinsic interest through interim self-motivation. *Journal of Personality and Social Psychology*, 41(3), 586-598.

Bills, Chris, Liz Bills, Anne Watson, and John Mason. *Thinkers—A Collection of Activities to Provoke Mathematical Thinking*. Derby, U.K.: Association of Teachers of Mathematics, 2004.

Bobis J, Anderson J, Martin A, Way J (pp.31-42) Chapter: A Model for Mathematics Instruction to Enhance Student Motivation and Engagement within book: Brahier, D. J., & Speer, W. R. (2011). *Motivation and disposition: pathways to learning mathematics*. Reston, VA, National Council of Teachers of Mathematics.

Durksen, T.L., Way, J., Bobis, J. et al. Motivation and engagement in mathematics: a qualitative framework for teacher-student interactions. *Math Ed Res J* 29, 163–181 (2017). <https://doi.org/10.1007/s13394-017-0199-1>

Heshmati, H, Johnston-Wilder, S and Sinclair, B (2018) Learners creating video revision resources to promote mathematics self-efficacy. In: BSRLM Summer 2018 Conference, University of Wales, Swansea, Wales, 9 June 2018. Published in: *Proceedings of the British Society for Research into Learning Mathematics*, 38 (2).

Kirby, S., M. Byra, T. Readdy, and T. Wallhead. 2015. "Effects of Spectrum Teaching Styles on College Students' Psychological Needs Satisfaction and Self-determined Motivation". *European Physical Education Review* May 7, 2015:1–20. doi:10.1177/1356336X15585010

Leaper, C., T. Farkas, and C. S. Brown. 2012. Adolescent Girls' Experiences and Gender Related Beliefs in Relation to Their Motivation in Math/Science and English. *Youth Adolescence* 41(3): 268–282. doi:10.1007/s10964-011-9693-z

Leeds City College (2017-2018). EDI Annual Report. Available at <https://www.leedscitycollege.ac.uk/wp-content/uploads/2019/10/LCC-Marketing-EDI-Final-Compressed.pdf> (Accessed 3rd December 2020)

Mackrell, Kate and Johnston-Wilder, Sue (2020) The mathematics resilience approach to mathematics anxiety : is this supported by self-determination theory? In: BSRLM Spring 2020, Cambridge, 7 Mar 2020. Published in: *Proceedings of the British Society for Research into Learning Mathematics*, 40 (1).

Macleod, G. 2006. "Bad, Mad or Sad: Constructions of Young People in Trouble and Implications for Interventions". *Emotional and Behavioural Difficulties* 11(3):155-167. doi:10.1080/13632750600833791

Martin, A. J., & Marsh, H. W. (2006). Academic resilience and its psychological and educational correlates: a construct validity approach. *Psychology in the Schools*, 43(3), 267–282.

Nguyen, G. 2015. "A Case Study of Students' Motivation in College Algebra Courses". *Community College Journal of Research and Practice* 39(8): 693-707. doi:10.1080/10668926.2013.824394

Oldham, Hannah H., "Mathematics Self-efficacy in High School Students and the Effects of Interim Goal Setting: How Goals and Efficacy are Linked in the Self-efficacy Goal Spectrum." Dissertation, Georgia State University, 2018. https://scholarworks.gsu.edu/mse_diss/51

Pajares, F., & Miller, D. M. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of Educational Psychology*, 86(2), 193-203

Reupert, A., and S. Woodcock. 2010. "Success and Near Misses: Pre-service Teachers' Use Confidence and Success in Various Classroom Management Strategies". *Teacher and Teacher Education* 26(6): 1261-1268. doi:10.1016/j.tate.2010.03.003

Schunk, D. H. (1995). Self-efficacy and education and instruction. In J. E. Maddux (Ed.), *The Plenum series in social/clinical psychology. Self-efficacy, adaptation, and adjustment: Theory, research, and application* (pp. 281-303). New York, NY, US: Plenum Press.

Small, Marian. *Good Questions: Great Ways to Differentiate Instruction*. New York: Teachers College Press, National Council of Teachers of Mathematics, and Nelson Education, 2009.

Stipek, Deborah, Julie M. Salmon, Karen B. Givvin, Elham Kazemi, Geoffrey Saxe, and Valanne L. MacGyvers. "The Value (and Convergence) of Practices Suggested by Motivation Research and Promoted by Mathematics Education Reformers." *Journal for Research in Mathematics Education* 29 (July 1998): 465–88.

Sullivan, Peter, and Pat Lilburn. *Open-Ended Maths Activities: Using "Good" Questions to Enhance Learning*. 2nd ed. Melbourne, Victoria, Aus.: Oxford University Press, 2004.

Warwick, J. (2008). Mathematical self-efficacy and student engagement in the mathematics classroom. *MSOR Connections*. 8, 31-37.

Appendices

- Initial survey - <https://forms.gle/oRx9FPZsxisS3muN7>
- Interview questions: <https://docs.google.com/document/d/1YXNHCQLqPF3kO0kzOCwykVW-zGeBBRYtTuTLjSIZPqQ/edit?usp=sharing>
- End point survey: <https://forms.gle/oGDDW73u2zq5BBXE6>
- Google form version of Focus 4: <https://drive.google.com/drive/folders/1GYEx-i9N3EtsKoubuMfM8O7RwkSrX9nf?usp=sharing>
- Mathsbox: <https://www.mathsbox.org.uk/gcse/focus/f4.php>
- Google site <https://sites.google.com/leedscitycollege.ac.uk/actionresearchlcc/action-research-project-1>