

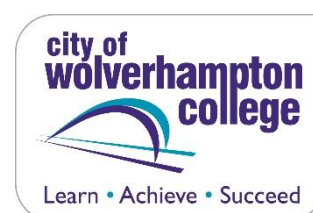
Increasing confidence levels in GCSE resit maths learners by using mastery principles

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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.

Abstract

Learners who are required to re-sit their maths GCSE at a Further Education college can feel they have 'failed' as a result of not achieving a grade 4, and therefore have low confidence levels and lack resilience. It could be argued that these learners have struggled at maths throughout their entire time in education, resulting in low self-belief in their mathematical ability. This has been even more prevalent following a year of teaching in a pandemic, and teacher assessed grades. This research aims to investigate strategies to increase the self-confidence of learners who have low self-belief, a fixed mind-set and potential maths anxiety.

All mastery principles (ETF Mastery Handbook) were considered during the first action research cycle, which led to "Key Principle 5: Belief in Success" being explored in more detail. Goal Free Problems were used as open self-differentiating questions, which allowed the learners to focus on their effort as opposed to goal related pressures, such as arriving at the right answer and achieving a certain number of marks. Students were given a multi-topic A03 question as a baseline measure, followed by 4 weeks of Goal Free Problems after which they repeated the initial A03 question, to allow direct and clear comparisons to be drawn. The learners' willingness to engage with the question was also rated. The pre and post intervention scores were analysed and compared across the colleges.

The intervention demonstrated an improvement in willingness and outcomes, which suggested the Goal Free Problems led to learners increasing in confidence and ultimately resilience.

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Background

Research Aims

This project aims to focus on building the resilience and confidence of GCSE resit learners, who have come to college following teaching in a pandemic year where they received teacher assessed grades and experienced disrupted learning. Additionally, it aims to consider the effects this may have had on confidence and resilience.

Research Objectives

1. To research measures of maths confidence and resilience and how these can be applied.
2. To trial a self-confidence measure.
3. To design an intervention which focuses on developing confidence and resilience using a mastery model.
4. To review the effectiveness of the intervention.
5. To share results and, if possible, effective strategies to improve resilience of FE GCSE resit learners with teachers, locally and nationally.

Introduction to the Research

This research project was conducted by 5 teachers in total, across 4 different colleges, including Newcastle and Stafford College Group (NSCG), Reaseheath College, Macclesfield College and City of Wolverhampton College. All 4 colleges deliver GCSE Maths resit to 16 to 19 year olds.

The colleges are all similar in terms of their vocational delivery. Reaseheath is a land-based college and has some slightly different courses compared to the other general FE colleges, such as Agricultural Engineering and Horticulture. In addition to this, Reaseheath doesn't deliver any A-level courses, whilst City of Wolverhampton College do not deliver Functional Skills courses to their 16 to 19 year old learners.

There were 112 learners included in the study, these were all GCSE resit learners, who had an entry grade of 1 to 3 and were sitting the foundation tier. Additionally, the only data which was included in the analysis was that of the learners who had completed both the pre and post assessment. A combination of timetable disruptions and Covid-19 resulted in the final learner numbers being much less than originally anticipated.

Initially the project intended to investigate resilience in FE GCSE resit learners, therefore the first objective was to find an effective measure of resilience. However, after a substantial amount of background reading, it became apparent that measuring resilience is extremely difficult. Furthermore, confidence and resilience appeared to be closely linked. Therefore, it was decided to attempt to increase learners' confidence, which would consequently increase their resilience.

Literature Review

This literature review considers previous research relating to learners who lack self-confidence, self-belief and maths anxiety. Confidence levels in GCSE Maths resit learners are minimal, even more so following a year of teaching in a pandemic. The disruption to education for these learners, who already have low self-esteem and maths anxiety, has been detrimental.

Bandura (1986) claims people who have no belief in their own ability to produce a desired outcome causes them to have no incentive to try. This lack of motivation is prevalent in GCSE Maths resit learners and this argument is supported by Highton (2017) who states that FE GCSE Maths resit learners have low motivation, low levels of confidence and poor understanding of the subject.

Bandura (1997) states that a learner's self-efficacy (a belief one has about their own academic ability) is often a result of their own successes or failures; learners interpret the outcomes of their own actions, for example, overcoming a challenge they found difficult. They also claim that individuals do not dismiss these experiences quickly, therefore successful performance, or failure to achieve a desired goal, can have lasting effects.

Crawford (1980) supports this argument, claiming a learner's lack of success in maths is a primary factor in causing maths anxiety, which ultimately causes the learner to lose confidence in their ability. Furthermore, Putwain and Daniels (2010) found a positive correlation between maths anxiety and learners' beliefs about achieving their goals. Learners with low belief in themselves reported worrisome thoughts about maths, and had adopted avoidance tactics. Unfortunately, GCSE resit learners have often endured a series of failures in their academic experiences, thus potentially explaining their lack of self-efficacy and resilience. Consequently, these learners are at risk of further failure. Therefore, there is a compelling priority to research strategies to increase learners' confidence levels and resilience.

Substantial evidence in this area suggests educators should strive to create a mastery focused classroom in order to increase learners' confidence and reduce maths anxiety (Bong, 2009; Karabenick, 2004; Lau & Nie, 2008; Furner and Gonzales-De Hass 2011). It is therefore essential to create a positive environment where learners strive towards growth and improvement, and are not just focused on goal related pressures, such as achieving full marks or desired grades (Furner and Gonzales-De Hass, 2011). Ames and Archer (2011) claim, when importance is placed on performance goals, learners tend to focus on their ability negatively, and evaluate this lack of ability as a cause of their failure. Additionally, they argue, when emphasis is placed on mastery goals, learners are more likely to believe that effort is positively related to success, which consequently may help to overcome the negative impact of learners' low self-esteem and lack of confidence, thus resulting in greater achievement and outcomes.

Furner and Gonzales-De Hass (2011) argue, learners with mastery goals have an interest in learning new skills, improving their understanding and engaging with the process, as opposed to being focused on the final outcomes. In a mastery-orientated classroom, success is about making some individual progress, and enables learners to make mistakes and reveal a lack of understanding without feeling embarrassed.

Lee & Johnston-Wilder (2018) also support the idea of allowing learners to make mistakes and they claim that this is one way for learners to build mathematical resilience. They argue that learners will develop resilience in a supportive environment where making mistakes is known to be perfectly acceptable, if this is not the case learners can be faced with feelings of

anxiety and avoidance. The article goes on to explain, when a learner struggles, then they are in the growth zone, which results in learning.

Therefore, this research project will consider the effect of implementing mastery strategies in the classroom, and ensuring the environment is positive and supportive. It will then analyse the impact this has on learners' confidence levels and willingness to try and attempt questions they previously may have avoided attempting. The mastery principles which will be investigated are taken from the ETF handbook 'Principles and Practice: Maths Mastery in Further Education', where mastery principles are adapted to suit FE learners.

Methods

Ethics

Prior to starting the intervention, all teachers discussed the project with their classes. Learners were fully informed about the aims of the project, what their involvement would look like, and that the data would remain anonymous and be kept securely. Learners were told to speak to their teacher if they had any concerns or questions about their involvement, and that they could withdraw from the intervention at any time. A statement was also added to the beginning of the surveys and learners were asked to tick a box to show that this information had been understood and agreed to.

Cycle one

During action research cycle one, all members of the team explored different mastery strands.

- Macclesfield College looked at prior learning, using diagnostic questions to fill gaps in the learners' knowledge.
- NSCG looked at using mathematical representations across a series of lessons, for example bar modelling and other visual representations.
- Reaseheath College investigated fluency and curriculum coherence and the impact that repetition had on confidence levels.
- City of Wolverhampton looked at fluency with SSDD, same surface, different depth structured maths problems.

To ensure consistency, all colleges used the same Likert scale to measure confidence. This was given to the learners before and after each intervention to determine if confidence had increased. However, the information collected did not offer any detailed insight into the learner's perspective and was considered unreliable. Although some interesting findings were noticed from these "mini interventions", it was decided it would be more representative, and produce more detailed findings, if all the teachers explored the same mastery strand.

After further background reading and discussions "Key Principle 5: Belief in Success" was chosen as a suitable mastery strand to explore in more detail alongside fluency and the repetition of a skill. This focused on changing the mind-set of GCSE resit learners by frequent exposure to AO3 style questions, encouraging them to "have a go" regardless of the end goal. Therefore, self-differentiating Goal Free Problem questions were recommended as a tool to explore this strand, as these are believed to reduce the cognitive load, allowing the learners to focus on the effort they put in, and not the end result.

Cycle Two

To ensure consistency, a set of PowerPoint slides were produced and used by all teachers throughout the project. These slides introduced the project to the learners and included the weekly Goal Free Problems and motivational messages.

In the first week, all learners were given an AO3 multi-topic maths question. This provided a baseline measure before any interventions were delivered. This question was marked according to the official mark scheme and scored out of 5 marks (See Appendix 1). In

addition to their baseline score, the teachers also observed the learners' willingness to engage with the question. They were asked to rate their learners' willingness out of 5, 1 being reluctant and disengaged, 5 being completely willing and engaged.

Over the course of the next 4 weeks the learners were exposed to Goal Free Problems that allowed for self-differentiation with a focus of identifying maths that was accessible to the learners. The learners were encouraged to note down anything they believed relevant or worthwhile to the information provided to them. During this period, learners were continuously encouraged to "just have a go", and not to worry about getting it wrong, to try to put something down that could potentially gain them marks. No time limits were given during this period. Once all learners had applied as much maths as they could to their problem, they were given a red pen and the teacher led a discussion-based review of the problem. Learners could annotate their work, tick or cross out their working and add to their notes. This process was repeated each week. During this time, teachers made observations on learner effort and, once again, rated their learners' willingness to engage with the Goal Free Problem. In addition to this, teachers made comments on the spreadsheet regarding their observations and how the learners responded to the activities. This provided some additional qualitative data for analysis.

The 4 Goal Free Problems were carefully selected around the schemes of work of all colleges involved. This selection ensured the Goal Free Problems were based on topics which the learners had already been taught within that academic year. After this 4 week intervention, the learners were then given the original baseline question. By completing the same baseline question, it allowed direct and clear comparisons to be drawn pre and post intervention. Marks were awarded to the problem in the same way as the baseline question, and once again a willingness score was given. The marks and willingness scores were recorded in a spreadsheet for analysis.

After completing the post intervention baseline question, the learners were all asked to complete a survey. The survey asked for learners' thoughts and opinions on Goal Free Problems and provided qualitative data for further analysis.

Results and Discussion

Results

The baseline question was given to all the learners before and after the intervention. To ensure consistency across different settings it was marked according to the mark scheme. These scores were recorded on an intervention record sheet. The difference in marks gained was recorded for each learner, and the average was calculated.

All colleges observed an increase in marks. The increase in marks has been broken down by college, as shown in *Table 1* below. The average increase in marks across all the colleges was 0.94, which equates to an 18.8% increase in marks after 4 weeks of Goal Free Problems. *Table 1* shows, the average marks were similar across three of the colleges (NSCG, Reaseheath College and Macclesfield College), however at City of Wolverhampton College, a much greater average increase in marks was noticed.

Table 1:
The average difference in marks gained across all colleges.

College	Students involved	Average marks gained.	Percentage
NSCG	20	0.7	14%
Reaseheath College	35	0.65	13%
Macclesfield College	34	0.76	15.2%
City of Wolverhampton College	23	1.86	37.2%

Across all colleges, the average willingness score was 0.85, which is an increase in willingness of 17%. This means the teachers noticed on average, the learners were 17% more willing by the end of the intervention. Across the three colleges (NSCG, Reaseheath College and Macclesfield College) the scores are quite similar, however, again at City of Wolverhampton College they saw a much greater average willingness score. This is shown in *Table 2*.

Table 2:

The average difference in willingness scores across all colleges.

College	Students Number	Average willingness marks gained	Percentage
NSCG	20	0.85	17%
Reaseheath college	35	0.56	11.2%
Macclesfield college	34	0.55	11%
City of Wolverhampton	23	1.7	34%

These results suggest there is a positive correlation between willingness to attempt a question and marks gained. After completing 4 weeks of Goal Free Problems, the learners were more willing to attempt the long worded, multi-staged problem, and thus managed to achieve more marks. While the willingness score was an extremely useful measure, and allowed for analysis of the learners' engagement, it was subjective, as different teachers may mark their learner's willingness at different levels due to their expectations.

In addition to the pre and post intervention question, all colleges asked their learners to complete a survey at the end of the intervention, in an attempt to gain qualitative data and a greater understanding about the impact of the Goal Free Problems. In the survey, 78% of learners reported they usually leave long worded questions blank in an exam. The reasons given were similar across all colleges with learners stating:

- They felt the questions were confusing
- There were too many words, which made it difficult to draw out the information required
- A lack of knowledge and understanding

When asked how confident they felt answering long worded questions after the intervention 81 out of 112 (72%) of the learners felt more confident after the intervention. The confidence of the learners after the intervention was recorded in *Table 3*. Once again, City of Wolverhampton College noticed a much higher increase in the learner's confidence after they had completed the intervention. The increase in confidence would suggest the learners had become more resilient.

Table 3:

The learners increase in confidence post intervention.

College	Learner numbers	Percentage who felt more confident
NSCG	12 / 20	60%
Reaseheath College	27 / 35	77.1%
Macclesfield College	21 / 34	64%
City of Wolverhampton College	21 / 23	91.2%

Learner attitudes towards the intervention

The intervention did have a positive impact on learner confidence and their willingness to attempt long worded questions, resulting in more marks. Feedback from the survey stated that some learners found the Goal Free Problems “confusing” and “frustrating”, with a lack of direction which left them with “nothing to go off”. The teacher reflections showed that some learners displayed negative attitudes during the intervention, and at times some learners were reluctant to engage with the activity and needed considerable encouragement. However, 47% of the learners did change their minds by the end of the project, reporting that they found the exam practice useful, which is very significant. Additionally, some commented that they quite liked that there was no “wrong” answer. Below are some typical learner comments taken from the survey responses:

“I realised I was over-thinking some exam questions, and that it is quite straight forward”

“I feel a little more confident with dealing with questions similar to these”

“I feel like I can do more, and there are more opportunities to get a mark”

These comments support the claims, that although they found the style of question challenging at the start of the intervention, nearly half of the learners did recognise the value of the Goal Free Problems and felt the benefit of them.

During the intervention, the teachers encouraged the learners to do their best, to try and demonstrate any maths they thought was relevant. The baseline question was marked according to the official mark scheme. However, some learners were disheartened due to not achieving marks despite them showing working out.

Discussion

The results show that using mastery principles in the classroom has had a positive impact on the learner’s confidence and willingness levels, making them more willing to attempt long worded AO3 questions. Therefore, this supports the literature, which suggested removing goal related pressures, and focusing on mastery principles, should allow the learners to believe that their effort is positively related to their success. This also supports Bandura (1997) who said the belief about their own ability is often a result of their own successes or

failures. It could be argued, that when the learners started to realise they were achieving more marks, and they were able to answer these complex multi-topic questions, that they started to have an increase in confidence levels.

Although the intervention has clearly had a positive impact, there are a range of factors which could have been influential during the delivery of the Goal Free Problems.

- **Breaking the questions down** - Initially the learners were given some time to write down all they could about the question, or any topics they thought were related. After which, the teacher then asked the learners to feedback to the class and all the notes were written on the white board. This process meant the exam question was really broken down and simplified for the learners. This seems to have been extremely beneficial, as the learners commented in the survey that they really struggle to understand what the questions were asking of them.
- **The repetition of the task** – this is a mastery strand in itself, fluency, and allows the learners to gain some familiarity with the question style and enables them to build their confidence.
- **The positive learning environment** - The intervention spanned across 12 lessons in total, over 6 weeks creating a positive supportive environment, by removing goal related pressures, which led to rapports being developed. In line with key principles of mastery this increased confidence, self-belief, motivation, engagement and resilience.

Why were the results at City of Wolverhampton College significantly higher?

Noted previously were the particularly strong results shown by the participants from City of Wolverhampton College. When explored in more detail, it was identified that the learners all had an entry qualification of a grade 3. In comparison, the collective data gained from the other colleges had mixed ability groups, therefore some learners only had an entry qualification of a grade 1 or 2. There is a strong suggestion that Goal Free Problems have greater impact on confidence and willingness for grade 3 learners given their greater understanding of mathematical key skills.

Goal Free Problems challenged the learners.

Although some of the learners displayed negative attitudes towards the intervention, as mentioned before, their confidence did increase, and more marks were achieved post-intervention. Given their prior attainment and the impact on confidence, it is not surprising to witness learners struggling to answer long worded exam questions in an FE setting. However, despite being challenged, the Goal Free Problems did have a positive impact on learner willingness and marks achieved, which suggests an element of learning did take place. This supports the claims of Lee & Johnston-Wilder (2018) that when a learner struggles, they are placed within the growth zone, and as a result of this learning takes place. It could be argued the Goal Free Problems pushed the learners out of their comfort zone, and into their growth zone, which allowed them to develop their mathematical resilience and understanding (See Appendix 2).

Limitations

The intervention was planned over a 6-week period, with the baseline question at either end, this left 4 weeks of Goal Free Problems. Even within this short time frame, there were disruptions. Covid-19 difficulties meant that either full classes were working from home, or teachers were absent. There were also timetabling disruptions such as mock exams and work experience, which meant some groups had gaps in the delivery of the intervention. This caused some interruption to the repetition element and meant some momentum was lost. Some learners whose data was originally included in the project, had to be later excluded from the results as they had missed too much of the intervention due to these disruptions. On reflection, more time for the intervention could have had a greater impact.

Conclusions and Recommendations

Conclusions

Initially some learners found the Goal Free Problems challenging, but as time went on the learners engaged and a significant increase in confidence was demonstrated across all colleges, with City of Wolverhampton College presenting the strongest results with streamed groups of grade 3 learners. Overall, the outcome was that this intervention led to the learners being more willing to answer the post intervention baseline question, thus achieving more marks and 72% of learners stating they felt more confident after the 4 weeks.

There were a variety of potentially influencing factors, which could have led to an increase in confidence, self-belief and resilience. They were:

- **Removal of the goal**
 - By removing the goal related pressure it reduced the cognitive load allowing learners to explore their maths knowledge.
- **The repetition of the task**
 - Applying mastery principles into the classroom - fluency, self-belief, motivation and engagement.
- **Breaking the questions down**
 - Breaking down AO3 long worded exam questions into manageable chunks.
- **The positive learning environment**
 - A positive and supportive environment created by the teachers and the removal of goal related pressures, allowed for the development of self-belief in their own success.

This activity has provided the learners with a transferable skill, which they can apply to an exam question that they may normally leave unanswered.

Recommendations

As a result of conducting this research various recommendations can be made to support learning in a FE classroom, and also for future research.

Removing goal related pressures from the classroom, allowing the learners to focus on their effort, and encouraging them to make mistakes in a supportive, positive environment is crucial for the development of self-belief, self-confidence and for learning to take place.

Repetition and consistency of activities is a really important element which should be implemented in the classroom, in order to overcome issues such as a lack of self-belief and low confidence levels. Repetition of skills support the learners' development and fluency with the activity and they consequently become more confident. Once they start to achieve some success, this can lead to an increase in self-belief and resilience.

In future when using Goal Free Problems, we would introduce concrete, pictorial and abstract methodology to improve fluency and understanding of mathematical structure which will lead to curriculum coherence and connections.

Although the Goal Free Problems are self-differentiating, we noticed that grade 1 and 2 learners did not benefit as much as grade 3 learners, therefore greater differentiation is required.

When teaching AO3 exam questions, it is more supportive to break the question down into more manageable sections. Providing them with the skills to do this will result in an increase in learner confidence.

The marking of the pre and post baseline question caused some discussion due to some learners not achieving marks despite showing working out. It is essential that learners' expectations are managed to demonstrate that their initial working out may not achieve marks, however it removes the cognitive overload, which over time develops their problem-solving skills.

It would also be advised to plan this intervention over an extended time period to allow for a greater number of Goal Free Problems to be included in the study and to mitigate the impact of disruptions.

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Appendices

Appendix 1

Name	Class day and time.
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Building confidence in GCSE Resit Learners - Baseline Question

Below is a maths question.

Look at the question and consider how you might go about answering it.

Then attempt to answer the question to the best of your ability.

Costcorp sells packets of mints to shop owners.

On Monday, three shop owners buy mints from Costcorp.

Each shop owner buys small packets, medium packets and large packets.

Alan buys 400 packets of mints.

32% are small packets

40% are large packets

Beryl buys 500 packets of mints.

$\frac{3}{10}$ are small packets

$\frac{1}{10}$ are large packets.

Charlie buys 150 small packets of mints so that

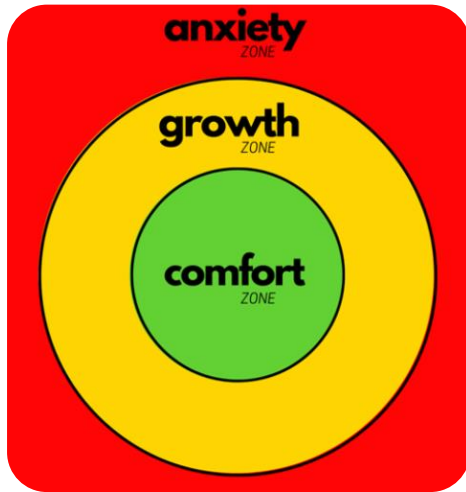
Number of small packets: Number of medium packets = 3 : 4

Work out the total number of medium packets of mints the shop owners buy.

You must show all your working.

Appendix 2

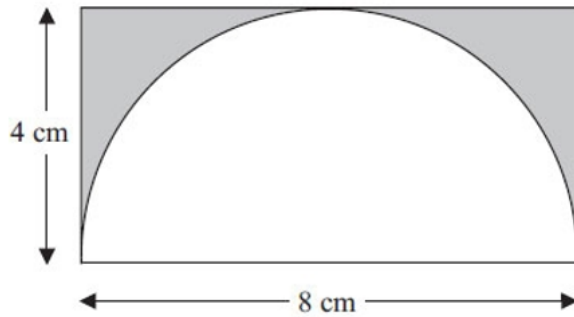
Growth Zone Model (Lee & Johnston-Wilder, 2018)



Appendix 3

Goal Free Problems

The diagram shows a semicircle drawn inside a rectangle.



The semicircle has a diameter of 8 cm.

The rectangle is 8 cm by 4 cm.

Work out what you can from this information.