



Alternative Learning Environments - Exploring maths teaching outside the traditional classroom environment

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About CfEM

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

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

Summary

To develop teaching practice and create sustained improvements in attainment, motivation and engagement of Maths GCSE resit and Functional Skills learners through a range of vocational specific interventions. These interventions will include core lesson support on mastery topics, team teaching activities on mastering maths for a vocation, holistic mentoring, signposting and ensuring a visible presence of maths in students' usual vocational settings, supporting a positive cross college maths culture.

Our action research group at City College Plymouth have researched the effects of outside the traditional classroom learning on the motivation and engagement of post 16 maths learners. Our findings have indicated the positive impact of alternative practical maths activities on learners and lecturers in a post 16 setting and have led to changes and development in on-site maths teaching and learning. Our key takeaways, with learners and lecturers feedback strongly suggesting the positive effects of these, are;

- Effects on learner behaviour, autonomy and resilience (the more open the space, the more open the learner)
- Learners therefore have more ability to engage with learning and progress their skills
- Lecturers have reignited passion and confidence to develop their teaching practice through the freedom to create and explore
- Effective lecturer/student relationships are formed.

From our data set of 204 students across 3 FE sites, we found that 92% of students involved enjoyed the alternative practical maths lessons, 84.3% of students felt they joined in more than usual for the alternative session, and 70.8% of students agreed that the activity supported the development of their maths skills. These findings greatly support our research hypothesis and mission to increase motivation and engagement of post 16 maths learners.

Contents

	Page
Background and Introduction	5
Literature Review	10
Method	15
Results and Discussion	19
Conclusions and Recommendations	25
References	27
Appendices	29

Background

Why did we choose alternative learning environments? And why continue our research?



Through the key themes highlighted in the Centres for Excellence in Maths programme (CfEM), our focus point has been the motivation and engagement of maths learners, as we believe this is the starting point in any learner's journey to access maths mastery, contextualisation and using technology to support.

When we began our research into alternative learning environments in 19/20, we reviewed the key principles for motivation and engagement and found striking links with the aims of learning outside the traditional classroom:

- Development of positive learning environments that are more engaging
- Linking maths learning to students' interests
- Sympathetic to students' usual ways of workings

“Learning outside the classroom is about raising achievement through an organised, powerful approach to learning in which direct experience is of prime importance. This is not only about what we learn but importantly how and where we learn” (OFSTED, 2008).

Our Demographic



Picture 1

City College Plymouth is an inner-city campus, with the student demographic reflecting this in respect to deprivation, access to services and resources. In walkable distance from the campus, there are outdoor spaces that students can enjoy. Plymouth encompasses a fantastic and diverse environment with surroundings of Dartmoor, as well as a beautiful coastline on its doorstep, lending itself to the development of alternative learning environments. Many previous research studies have shown the benefit of access to outdoor space on overall health and wellbeing, with mental health being a huge consideration for any educational organisation in current times (see literature review).

Due to the conditions of funding for post 16+ maths education, many students are retaking their qualifications, and there are often high levels of subject-related anxiety within the cohorts, which can be triggered by a traditional classroom environment. Factors in a classroom environment that can lead to maths anxiety include “unrealistic expectations of students; gender bias; giving poor explanations; hostility, anger or intimidation; embarrassing students in front of peers if a concept is not understood; and, an insensitive or uncaring attitude” (Shields, 2005). In addition to this COVID has brought its own challenges and barriers for students, exacerbating maths anxiety and many other fears surrounding education and progression, alongside having had no GCSE exam experience previously in 19/20 and 20/21 academic years.

Currently, throughout all key stages, learners in Plymouth are under the national achievement rate in mathematics, and organisations within Plymouth are working together to overcome “The Plymouth Challenge” which focuses on Secondary School standards. “The percentage of pupils achieving ‘the basics’ in Plymouth is 58.8% which is below the national average of 59.4% and statistical neighbour average of 61.5%. By the end of KS4, the progress made by Plymouth pupils is below that made by similar pupils within the statistical neighbour group. The progress made by disadvantaged pupils is below that of non-disadvantaged pupils at the end of KS4.” (Plymouth City Council, 2019). A high percentage of our students

will be in this KS4 category, as our FE College is one of the main providers for 16-18 learners in Plymouth and the surrounding area. Although there is little research at present, we predict that the covid pandemic will have increased the number of students needing support with basic numeracy and literacy skills across all key stages for the coming years.

Action Research Group

Our action research group has a wide variety of teaching experience with learners of all ages and abilities, different subjects, in specialist units, within the armed forces and in vocational settings. Members of the team completed training in outdoor learning through the Erasmus+ Project in Sweden with OutdooredU. This training and range of expertise inspired the development of alternative learning environments for students and the incorporation of outdoor activities. In 21/22, we have the addition of a fantastic mentor who has joined the team, Moj Taylor. Moj is a comedian, actor and inspirational education based speaker, with a huge interest in making education accessible for all and the beneficial effects of the outdoors and learning environment. With Moj's support we have also begun to research the effect of comedy/humour on reducing maths anxiety and as a tool to increase information retention.

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Darren Kimmince - Programme Lead for Functional Skills Maths

Moj Taylor – Action Research Mentor

Research Development

Based on the past 3 years of research, we believe that our findings strongly suggest maths learning outside the traditional classroom environment to be a positive development in teaching and learning for post 16. We therefore continued our research for 21/22, with adaptations based on feedback from the research team, colleagues, network and learners. 21/22 has been our first full year back on site following the COVID pandemic so we were determined to ensure all alternative maths sessions were delivered face to face this year.

In order to draw stronger conclusions and continue to develop good practice, we created a wider range of alternative maths sessions and adapted the structure and delivery of these to reach a larger number of students, therefore increasing our data set. As part of these improvements, we developed further our “Compete with ME” range of lessons which are included in the SoW (scheme of work) for all maths learners cross college. Within the “Compete with ME” sessions, we developed the use of comedy/humour and gamification as a tool to support learners to decrease their maths anxiety and engage more with learning.

Our initial aim was for the research this year to be based at up to 5 FE College sites working with L2 Functional Skills Maths students, and GCSE maths resit students that previously obtained a 3. We have carried out the research this year on our main campus of City College Plymouth and our satellite sites Piquet Barracks (alternative education site) and Monterey House (specialist autism unit). Exeter College were due to take part in the research, however due to ongoing COVID effects and staffing changes this has not been possible this year.

Our research for 21/22 has included 5 outside the classroom activities across Sept – June, based on mastery principles, with each session devised to be a recap session of key topics therefore allowing for flexibility within the SoW and transferability for network partners.

For 21/22, we have continued the collection of student and staff feedback following an alternative maths session, using various elements including Likert Scales, to assess key areas of engagement, maths confidence levels and gather qualitative feedback.

Our ongoing key focus has been motivation and engagement of post 16 maths resit learners, however we have developed further the incorporation of maths mastery principles.

Our initial research objectives for 21/22;

1. To understand current mathematics practice and linking the curriculum to support their vocational subject where possible.
2. To develop an effective end-to-end process for teachers to capture learners' vocational backgrounds and usual ways of working, and apply them to maths learning.

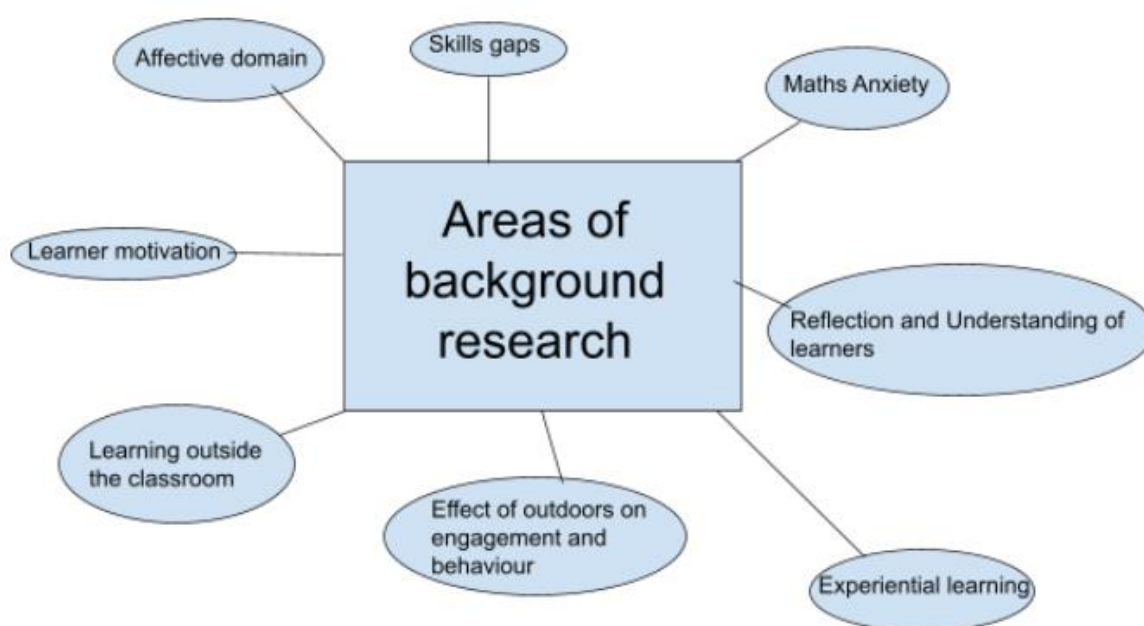
3. To design a range of practical activities, based outside the traditional classroom, to compliment the FS and GCSE SoW and support a mastery approach.
4. To analyse the effectiveness of the practical maths activities with regard to learner motivation and engagement, through a series of student feedback surveys and forums, alongside lecturer feedback and periodic diagnostic assessment following the activities.
5. To investigate whether there are differences in levels of engagement by learner characteristics (Age, Gender, SEN, Functional Skills Level 2, GCSE Grade 3 etc.)
6. To assess and explain ways in which practical activities support maths mastery.
7. To share results and, if possible effective approaches, with L2 and GCSE maths re-sit teachers locally and nationally, as well as our wider educational network.

Literature Review

A good literature review alongside summarising its sources, also analyses and evaluates to give a clear picture of the knowledge gained on the subject. With this in mind at the beginning of our alternative learning environments research in 19/20, we started off with a clear mission and action research question as our starting point. This allowed us to focus on the relevant material that would best support us. We looked at a variety of sources including published literature, online education articles and published research reports to evaluate which literature best suited our action research, and we have continued to develop this base of understanding throughout 20/21 and 21/22. Throughout the research we have also utilised the expertise within our action research group (ARG) and wider regional and national network colleagues. Our research has been positively supported and complemented by our ongoing learning as well as shared best practice from the 21 CfEMs and feedback from students, staff, SLT, network partners and wider community.

As an ARG, our starting point for each new cycle is to review and develop our research, and consider the relevance of published research literature to support our work moving forward.

The key areas we highlighted as an ARG that we wanted to research and that would support our aims in the beginning of our research in 19/20 are as follows;



Through our initial discussions as an ARG, we really delved into the role of researchers and how ongoing reflection and development leads to understanding our students better. The following article, Learning to look through the eyes of our students: action research as a tool of inquiry by Arhar and Buck, highlights;

“Our aim as action researchers is to improve our teaching by using professional (informed) eyes to observe our own practice (Arhar et al, 2001).”

“.....by looking through the eyes of our students, we become more conscious of our purposes, our own unquestioned assumptions, and ourselves. By focusing on how our students see the world, we may see our own world with new eyes.”

As a key focus, we continued to research maths anxiety and tools to support this, as well as adaptations of teaching approaches to challenge perceptions and broaden horizons. The Pearson 2020 guide to tackling maths anxiety, draws on research and insights from leading experts across education, academia, and the third sector who attended Pearson's 2019 Power of Maths roundtable to help address the issue which is widely apparent in post 16 settings.

This guide resonated with us as an ARG, especially this quote from Bobby Seagull (2019) “I have witnessed how maths anxiety can negatively impact the competence and confidence of people in dealing with maths. This can sadly harm their ability to engage with maths for the rest of their lives...Together, we must continue the conversation and fight for the wonder of maths.”

Building the wider confidence and resilience of our learners in post 16 settings is a key to supporting them to develop their maths skills and engagement with learning. Our aim is to encourage the building of these skills through taking maths learning outside the traditional classroom environment and/or structure.

Furthering our research into the bigger picture of maths anxiety, as an ARG we looked into tools to tackle maths anxiety. An article from TES (2019), How can we tackle maths anxiety? examines the level of maths anxiety and culture towards this within the UK. The article highlights the importance of new approaches including practical/active learning, communicating mathematically, and working with students to encourage a more curious and positive approach to maths teaching and learning. The article quotes “Along with many misconceptions about the value and usage of maths in adult life, the problem is exacerbated by a culture in the UK where it is surprisingly acceptable to be negative about maths. It’s not uncommon to hear people say “I’m bad at maths” or “numbers aren’t my thing”, with some even wearing this as a badge of pride.”

In relation to the new OFSTED framework for maths teaching - “Other methods to build confidence include supporting students to communicate mathematically, generalise and explore relationships. An impact study of a resource like this demonstrated that 95% of teachers said that there was a positive impact on pupil enjoyment of mathematics as a result of these methods being implemented in their school. Being active, illustrating and talking are all part of communicating mathematically, and this active approach from the start helps to remove the fear and anxiety surrounding maths.”

Following on from this, we developed our research in the area of alternative learning environments and their effect on engagement and behaviour, starting with the great outdoors!

A report by Bjorge, Hannah,; Rekstad and Pauly (2017), The Behavioural Effects of Learning Outdoors, explores the behavioural effects of outdoor learning and the effect of sensory learning outdoors on improvement of behaviour and engagement.

Within our action research on alternative learning environments we are including practical maths sessions that use outdoor spaces accessible to FE colleges.

Through roundtable discussions on practical maths activities, we looked into experiential learning and how this could support our research. Higgins and Nicol (2002) in their book *Outdoor Education: Authentic Learning in the context of Landscapes* (Volume 2) explore several aspects of outdoor learning and the effect this has on learners. A key focus in their writing is experiential learning, the accessibility of this for learners, and looking at challenge/gamifying/problem solving approaches to maths teaching and learning outside the traditional classroom environment can positively affect teaching and learning.

An area that became apparent to look into following 19/20 is the affective domain and subsequent relation to learner motivation which we have developed in our research in 20/21 and 21/22.

Russell (2004) in his report *The importance of the affective domain in further education classroom culture* led us as an ARG to look at how we could develop best practice in this through outside the classroom learning. We have incorporated more lecturer involvement in the practical maths lessons throughout 20/21 and 21/22, with a view to support the building of effective learner/lecturer relationships, and a vital part being that all lecturers took part in the practical activities alongside the learners to encourage a more horizontal relationship/hierarchy.

It has been important throughout our action research journey to consider our demographic, for which we used *The Plymouth Report* (2019). The Plymouth Report is a fantastic resource for us to explore and define the local community and skills gaps. The report also examines access to outdoor spaces and resources in Plymouth.

Learning outside the classroom has been an ongoing area of educational research especially in Primary and Secondary settings, so our mission is to progress this at FE level. By increasing the data set year on year for our research, we are able to see positive suggestions on the effect alternative learning environments and practical maths activities outside the classroom have on post 16 maths resit learners.

OFSTED's (2008) *Learning Outside the Classroom Manifesto* supports the aims of our action research, and allows us to explore other educational establishments' experience of learning outside of the classroom. Our action research incorporates 5 practical outside the classroom maths lessons across the academic year and SoW and was informed by some key points from the manifesto findings;

"When planned and implemented well, learning outside the classroom contributed significantly to raising standards and improving pupils' personal, social and emotional development."

"Learning outside the classroom was most successful when it was an integral element of long-term curriculum planning and closely linked to classroom activities."

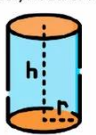
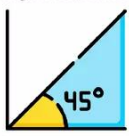
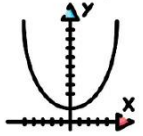
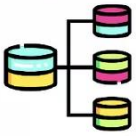
"Schools and colleges should:

-ensure that their curriculum planning includes sufficient well-structured opportunities for all learners to engage in learning outside the classroom as a key, integrated element of their experience

-evaluate the quality of learning outside the classroom to ensure that it has maximum impact on learners' achievement, personal development and wellbeing

-ensure equal and full access for all learners to learning outside the classroom by monitoring participation in activities by different groups of learners and removing any barriers."

To devise our alternative sessions, we have developed a maths mastery approach for 20/21 and 21/22, deciding as an ARG on what underpinning maths concepts we could incorporate into our practical activities to boost learner understanding. To support this, we were inspired by the work of fellow CfEM Grimsby College who created the Focussed 15 concept (see picture 3).

This is YOUR year!				
FF01 Types of Number 	FF02 Using Number 	FF03 Simple Probability 	FF04 Ratio 	FF05 Measures 
FF06 Rounding & Approximation 	FF07 Perimeter, Area & Volume 	FF08 Proportion 	FF09 Simplify & Solve 	FF10 Percentages 
FF11 Angle Properties 	FF12 Representing Data 	FF13 Solve & Graph 	FF14 Averages & Spread 	FF15 Transformations 

Picture 2

A further development for our research in 21/22 was the use of comedy/humour within sessions. Research studies have shown that humour supports to activate the brain's dopamine reward system, stimulating goal-oriented motivation and long-term memory. This therefore enables learners to improve retention of information. In an article named Laughter and Learning: Humor Boosts Retention by Sarah Henderson,

the most successful ways to utilise humour in educational settings are listed as the following;

Do

- Use humour to enhance classroom joy
- Use humour to develop a sense of community
- Use content-related humour
- Use age-appropriate humour
- "Sandwich" humour between instruction and repetition

Avoid

- Sarcasm
- Cruel or inappropriate humour
- Forced humour
- Off-topic humour
- Too much humour

A research study in Malaysian Secondary Schools by Amran and Saemah (2017) The Use of Humour in Mathematics Teaching and Its Relationship with Students' Concentration and Motivation, found that students reported that the use of humour in their maths lessons enhanced their concentration and learning motivation.

As an ARG, we set out to devise ways of including humour in the sessions fitting to these suggested principles. We decided to include comedy in a variety of ways such as the set up of the environment and costumes, ice-breaker style movement activities, funny stories to support with memory and retention, and generally creating an open, community focussed, comfortable and relaxed feel to the sessions.

Method

Our question: “To develop teaching practice and create sustained improvements in attainment, motivation and engagement of Maths GCSE resit and FS level 2 learners through a range of vocational specific interventions. These interventions will include core lesson support on mastery topics, team teaching activities on mastering maths for a vocation, holistic mentoring, signposting and ensuring a visible presence of maths in students usual vocational settings, supporting a positive cross college maths culture.”

Initially we needed to define what we meant by engagement in order to ensure we could measure this. Research helped us to explore this as having 3 interconnected points “encompassing three interconnected dimensions: behavioural engagement, cognitive engagement, and relational engagement.” (Davis, et al 2008).

We focused primarily on cognitive and behavioural engagement. Cognitive engagement was defined as “a matter of students’ will—that is, how students feel about themselves and their work, their skills, and the strategies they employ to master their work”. (Metallidou & Viachou, 2007).

Behavioural engagement was defined as that which “encompasses students’ effort, persistence, participation, and compliance with school structures.” (Davis, Shalter-Bruening, & Andrzejewski, 2008).

We also considered relational engagement/affective domain in the context of ensuring that the student’s normal lecturer was actively involved in taking part in the practical activities, and that members of the ARG team were present to really support and boost student activities during the sessions, removing hierarchy aspects. Our work with our research mentor Moj, also led us to including elements of comedy within our 21/22 sessions to again increase the learner/lecturer relationship and further remove barriers within the learning environment.

To measure students’ cognitive and behavioural engagement we chose to consolidate 2 pieces of evidence: an anonymous student survey (appendix 1) and a staff interview (appendix 2) following the practical maths activity which included elements of observation. Each type of evidence collection featured the opportunity to measure both cognitive and behavioural engagement.

To devise our practical maths sessions as an ARG we had round table discussions to highlight the areas that would benefit from active, experiential learning using mastery concepts such as the Focused 15 to instigate ideas - we narrowed these down to speed/distance/time, area, data collection and analysis, statistics and number, alongside holistic skills such as problem solving, memory and confidence building whilst being aware that all these areas would consolidate basic maths skills such as addition and subtraction.

Throughout our research process it has been fantastic to see the ongoing passion and enthusiasm that thinking “outside the box” creates for our ARG. The

development of our “Compete with ME” sessions for 21/22 also allowed us to reach more learners and create a sustainable model for the use of alternative maths sessions moving forward, ensuring legacy of the CfEM project post March 23. The team also worked on the addition of comedy elements to the sessions, which our background research suggested would increase engagement, focus and information retention, as well as reduce anxiety of learners.

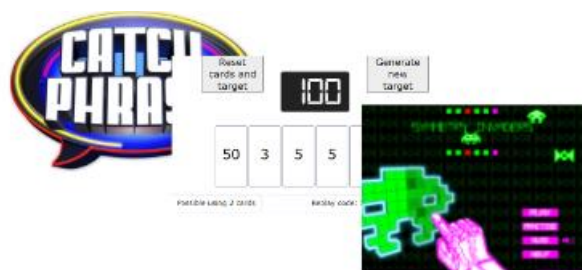
Our 5 sessions in 21/22 were as follows;

- Session 1 - There's been a murder!



Interactive murder mystery session including statistics, surface area, data collection, conversion, problem solving and speed/distance/time, which can be carried out in the science lab, or any space within a College campus where you can set up a murder scene!

- Session 2 – Compete with ME – Gameshow



Integration of comedy with member of the ARG team acting as gameshow host (sparkly costume!). 3 rounds with learners working in teams. Covering countdown style quick basic maths, catchphrase for mathematical language and symmetry invaders for shape, nets, symmetry, and rotations. Can be held in any large theatre style space but also easily transferable to any environment available.

- Session 3 – Escape Room

Problem solving session working in small teams to escape the maths centre! Puzzles including codes, algebra, basic number and also covering communication skills. Can be transferable to any environment available.

- Session 4 – BearMade “You can’t learn if you are stressed, you can’t learn if you are distracted”



Outdoor session supporting learners to build their soft skills and confidence. Areas covered included basic number, statistics, alongside memory, retention and revision skills, as well as environmental education elements. Great session for a completely open environment, with outdoors being the optimum.

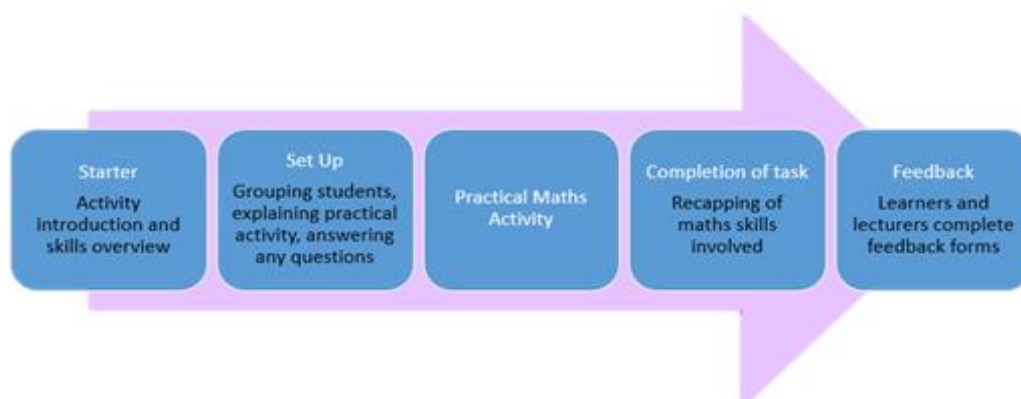
- Session 5 – Compete with ME – STEM focus



Interactive session building a balloon car in teams. Covering STEM based maths skills including speed/distance/time, problem solving, and practical construction. Transferable to all environments.

See Appendix 3 for information on resources.

Session structure:



Over the course of the year, we completed the sessions with students from our main College campus, our specialist partner site Piquet Barracks where students often have complex behavioural or emotional considerations and are generally on short term programmes to enable integration into mainstream education or employment, and with our specialist Autism unit Monterey House. This allowed us to observe the effectiveness of the alternative sessions on learners with a wide variety of additional considerations and/or special educational needs.

We also looked at historical and current information, so that we could include the following;

- Students with heavy practical elements in their core programme to be sympathetic to their usual ways of working
- Cohorts where engagement and focus in lessons can be challenging
- Cohorts where attendance is poor or drops throughout the academic year.

For each session, we had a minimum of 2 members of staff, which meant timetabling of lessons and staff availability were also considerations to ensure the sessions were successfully delivered. The students' usual maths lecturer was present alongside another member/s of the ARG. The development of Compete with ME greatly supported this as it is now a blocked out week of the timetable at 3 points across the academic year whereby all maths learners take part in the alternative session.

Returning to our first full onsite year after COVID, we planned in a way that we could adapt the sessions to a virtual/online environment, but felt as a team face to face delivery in an authentic alternative environment was important for the essence of the research. Fortunately, all sessions were able to be delivered on site in the environments and attendance was successful throughout the year. Our now SoW incorporated Compete with ME sessions will ensure that learners will experience 3 alternative environment maths sessions each year moving forward.

For ethical considerations, the students were informed of the action research and alternative lesson at the beginning of each session, and given the option to withdraw from taking part, however we found that students were keen to be a part of the experience and had no students withdraw.

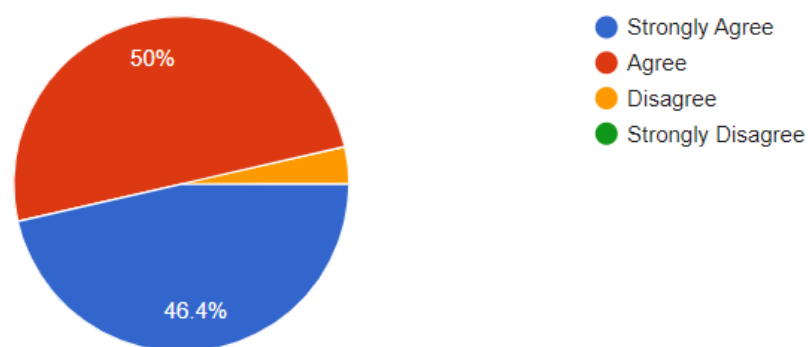
Results and Discussion

To begin in our initial eyeballing of the data, we were pleased to see that on average of the 5 sessions 92% of learners enjoyed the alternative sessions because enjoyment is a vital component of motivation and engagement. The alternative session which had the highest enjoyment rating was “You can’t learn if you are stressed, you can’t learn if you are distracted.”

Figure 1. “You can’t learn if you are stressed, you can’t learn if you are distracted.”

I enjoyed today's session

56 responses



The student survey was designed to collect evidence of both cognitive and behavioural engagement. Overall, the results were very positive with students showing cognitive engagement: with on average for all sessions 70.8% of students answering either agree or strongly agree to the question of whether the activity helped them with their maths. Learners scored the Compete with ME – Gameshow session the highest for supporting to build their maths skills.

Figure 2. Compete with ME - Gameshow

I think this activity helped me with my maths

62 responses

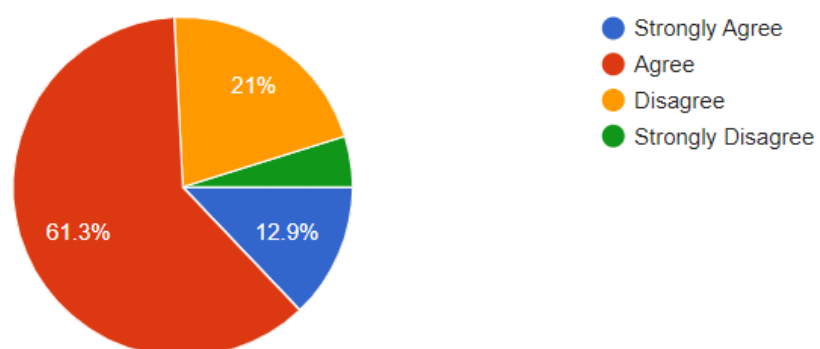
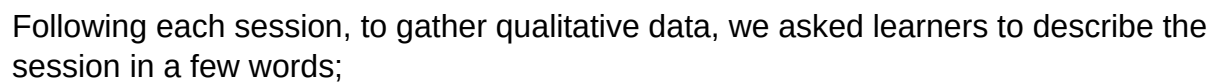


Figure 3. Compete with ME – STEM focus



A word cloud of adjectives describing the experience. The words are arranged in a circular pattern around the center. The largest word is 'calming', followed by 'amazing' and 'education'. Other words include 'funny', 'welcoming', 'educational', 'sweet', 'together', 'interesting', 'reconnecting', 'wicked', 'joyful', 'sound', 'great', 'enjoyable', 'refreshing', 'nice', and 'relaxing'.

great
sweet
sound
joyful
reconnecting
wicked
together
interesting
educational
welcoming
funny
calming
amazing
enjoyable
refreshing
nice
relaxing
education

Figure 5. Compete with ME – Gameshow



A key addition to our research this year was also the integration of comedy. To measure this we asked learners whether they laughed in the alternative session and what made them laugh. We found that on average across the sessions 87.4% of students laughed during the activities. Comedy was integrated in a variety of ways such as the set up of the environment and costumes, ice-breaker style movement activities, use of silly stories to support with memory and retention, and in general the hard work of the ARG and lecturing teams to create an open, comfortable and relaxed feel to the sessions.

To further establish our findings we also carried out staff interviews to find out their experience of the activity. It should be noted here that the usual class teacher was present and supported students with the practical maths activities. The results for effects on learner behaviour show some really positive suggestions that behaviour is better and staff recorded behaviour as ranging between 6-10 (positive Likert scale). From lecturer feedback, it was noted that learners seemed more focused than usual and engaged for longer periods within the session. Lecturers also commented that learners enjoyed the elements of competition and comedy and seemed more determined to answer and complete the tasks. This was across the board with the learners involved, which positively suggests the effectiveness of the sessions for learners of all levels and additional needs. With all sessions, there is the flexibility for them to be adapted for learners of varying levels and considerations for example reducing number of individual activities, increasing support available or splitting into 2 sessions.

From a lecturer point of view, in the context of cognitive engagement teachers gave a score of between 5-10 (positive Likert scale) for students' interaction with them, and the majority of feedback indicated students were more focussed, proactively taking part in their learning experience and showing increased confidence.

Discussion

For our first year returning to site full time post COVID, as an ARG we are really pleased to have increased the data set to 204 learners in 21/22. Our research work from 2019 onwards strongly indicates that maths learning outside the classroom is a positive development in teaching and learning for post 16 mathematics. Although there were no lockdowns, we did still find this year that COVID continued to effect the anxieties and social interactions of learners and lecturers so it was important to be mindful of this and be flexible when needed. Due to COVID issues and staffing changes, Exeter College were not able to take part in the research this year, however will aim to use the practical sessions that have been created on their sites alongside the rest of our network partners moving forward.

From our data set of 204 students across 3 FE sites, we found that 92% of students involved enjoyed the alternative practical maths lessons, 84.3% of students felt they joined in more than usual for the alternative session, and 70.8% of students agreed that the activity supported the development of their maths skills. These findings greatly support our research hypothesis and mission to increase motivation and engagement of post 16 maths learners.

Our initial objectives were as follows throughout 20/21 and 21/22;

1. To understand current mathematics practice and linking the curriculum to support their vocational subject where possible.
2. To develop an effective end-to-end process for teachers to capture learners' vocational backgrounds and usual ways of working and apply them to maths learning.
3. To design a range of practical activities, based outside the traditional classroom, to compliment the FS and GCSE SoW and support a mastery approach.
4. To analyse the effectiveness of the practical maths activities with regard to learner motivation and engagement, through a series of student feedback surveys and forums, alongside lecturer feedback and periodic diagnostic assessment following the activities.
5. To investigate whether there are differences in levels of engagement by learner characteristics (Age, Gender, SEN, Functional Skills Level 2, GCSE Grade 3 etc.)
6. To assess and explain ways in which practical activities support maths mastery.
7. To share results and, if possible effective approaches, with L2 and GCSE maths re-sit teachers locally and nationally, as well as our wider educational network.

We have explored these objectives, in particular ensuring that all sessions contain mastery principles and developing ways for these to fit flexibly into any post 16 maths resit SoW. By creating recap and refresh sessions such as Compete with ME, these can be used at any point within the academic year with learners. We have

begun to investigate further differences in levels of engagement by learner characteristics such as additional SEN or behavioural considerations, with our findings strongly suggesting that alternative learning environments and outside the traditional classroom maths sessions support in the improvement of engagement and behaviour for learners across the board. We have now ensured the legacy of our alternative session work, as Compete with ME is included in the SoW at City College moving forward, with every maths learner experiencing 3 sessions across the academic year.

Returning to our first full onsite year after COVID, we planned in a way that we could adapt the sessions to a virtual/online environment, but felt as a team face to face delivery in an authentic alternative environment was important for the essence of the research. Fortunately, all sessions were able to be delivered on site in the environments and attendance was successful throughout the year.

In regard to student feedback, there are a number of external factors that may affect the responses to and results of these feedback statements following the sessions including; increased anxieties following COVID, timing of lessons, weather conditions for the outdoor session and the effect this has on enjoyment of the activity, and the student completing the survey and the level they usually engage with their maths lessons, lecturer and class members. Variation may also be attributed to the difference in traditional lesson format and outside the classroom resources between the City College Plymouth, Piquet Barracks and Monterey House sites.

A potential barrier in any teaching/learning style change is the lecturer's mindset and it is important that lecturers feel empowered to embrace new ways of working and alternative environments. There is an element of fear associated with change, and a key aspect is to develop the lecturer/student trust relationship. Through the research the ARG were able to access high quality CPD to drive their teaching practice forward and gain a wider understanding of alternative learning, student motivation, maths anxiety and the benefits of teaching and learning outdoors on staff and students.

Our action research is a step forward in the differentiating of post 16 maths learning from that which students have experienced at Secondary School, with an aim to treat the student in a more adult manner and allow them to practically experience and have ownership of their maths learning. Our current findings over the 3 years indicate positive observations on student behaviour, and we will continue to monitor this post research and throughout the legacy of CfEM post March 2023. We can see the pattern that practical, outside the traditional classroom environment sessions support maths learning to become more of a "level playing field", encouraging students that may lack confidence in a classroom environment normally, to engage and take part more, increasing their autonomy and therefore increasing their learning opportunities and setting in concrete of crucial underpinning maths concepts. Through the use of comedy in 21/22, we have been able to further see that removing the constraints of a 4 walled classroom setting and its more set structure, supports learners to feel comfortable, less inhibited and relax, enabling them to retain information and utilise their skills. Our learner feedback would suggest that the more open the environment,

the more open and receptive the learner, with our outdoor woodland session being rated the most enjoyable.

Through our network, local organisations have keenly followed our action research including STEM Plymouth and the Plymouth Education Board, and within our network we have Primary and Secondary Schools, FE Colleges and HE providers as well as local alternative educational organisations, who have been able to access our practical maths activities and adapt them for their own settings. With all sessions, there is the flexibility for them to be adapted for learners of varying levels and considerations for example reducing number of individual activities, increasing support available or splitting into 2 sessions.

During our March 2020 OFSTED inspection, we were thrilled that our action research was commended for the use of memorable practical activities to help learners grasp important mathematical concepts. *“Leaders help teachers to teach well by providing useful training and encouraging teachers to be innovative...Mathematics teachers have also experimented with taking learners out of the classroom... These memorable practical activities help learners to grasp important mathematical concepts”* (City College Plymouth OFSTED report 2020).

Across our whole community at City College Plymouth important leaps forward have been made in student and staff engagement with maths since becoming a CfEM in 2019, and our action research has supported this further, linking with practical skills and making maths visible throughout the whole organisation. Throughout the academic year 21/22, wider College staff have also been involved, experienced and taken part in our alternative maths sessions, increasing engagement, support and enthusiasm for maths learning as a whole with both lecturers and learners. For staff training day, all College staff took part in an outdoor alternative session to see how the principles could be translated to their own vocational settings. The research has led to changes in our teaching practice at City College Plymouth with the incorporation of our research practical maths sessions across the academic year in the SoW, and this will continue as a legacy past the end of the CfEM project in March 2023.

Conclusions and Recommendations

Conclusions

This paper has discussed the overview and benefits of our alternative learning environments action research for students and staff at City College Plymouth, Piquet Barracks and Monterey House, with our mission being to improve the motivation and engagement of maths Functional Skills and GCSE re-sit students in FE Colleges by developing maths learning outside the traditional classroom environment. This has included elements such as alternative lessons on mastery topics, team teaching activities, holistic mentoring approaches and ensuring a visible presence of and positive culture towards maths cross college.

The overriding aim of our research from 2019 onwards was to have a positive impact on students' maths learning and to create new and innovative ways to support students to overcome maths anxiety and use practical based activities to support students with underpinning maths mastery concepts. Our research highlights the resources available to post 16 settings and how these can be utilised to encompass maths learning in environments outside the traditional classroom, and therefore can encourage a drive forward in post 16 maths teaching and learning. Our findings suggest that outside the traditional classroom maths learning does have a positive impact on students' motivation and engagement with maths learning. The research has also supported and encouraged lecturers to strive forward in their teaching practice, and the organisation as a whole with more practical maths activities outside the traditional classroom environment now included across the board. Lecturers involved have felt more comfortable to think innovatively and in a less constrained manner when creating and planning maths lessons. Through CfEM legacy, we want to continue to build links within vocational settings to further embed and contextualise maths in each vocation through practical "outside the box" lessons and activities.

A key conclusion from our research is the suggested positive effects on behaviour of learners and therefore engagement with their maths learning. Our research highlights the importance of cognitive, behavioural and relational engagement being considered when teaching maths in post 16 settings, in many ways due to the additional considerations resitting learners may have such as maths anxiety.

Overall, there are many positive effects and suggestions from our action research project in relation to both staff and students.

Recommendations

Key takeaways

- Develop timeframes/schedules to spread alternative lessons across the year, creating a FE SoW
- Continue with high quality CPD to upskill staff and work with a wider pool of network partners
- Increase avenues for learner feedback
- Further develop collaboration and team teaching of vocational focussed embedding of maths and contextualisation through practical maths activities
- Encourage creativity and innovation of practice
- Continue to develop a positive maths cross college culture and share this good practice

References

Background research

Bjorge, Shannon; Hannah, Tracy; Rekstad, Peggy; and Pauly, Tara. (2017). The Behavioural Effects of Learning Outdoors.

Higgins, P and Nicol, R (2002) Outdoor Education: Authentic Learning in the context of Landscapes (Volume 2)

Russell, M. (2004) The importance of the affective domain in further education classroom culture. *Research in Post-Compulsory Education*, 9(2).

Math Academy Online/ Platonic Realms (2006) Copyright © 1997–2006, Do You Have Math Anxiety? A Self Test Rate your answers from 1 to 5; add them up and check your score below. (1) = Disagree, (5) = Agree. (n.d.). [online]. Available at: <https://www.ucmo.edu/offices/learning-commons/digital-learning-commons/math-anxiety-test.pdf> including information from “Coping with Math Anxiety,” by B. Sidney Smith

Arhar and Buck (2006) Learning to look through the eyes of our students: action research as a tool of inquiry,
<https://www.tandfonline.com/doi/abs/10.1080/09650790000200115>

Multiple authors (2020) The Pearson 2020 guide to tackling maths anxiety <<https://www.pearson.com/content/dam/one-dot-com/one-dot-com/uk/documents/subjects/mathematics/guide-to-tackling-maths-anxiety-power-maths-report.pdf>> [Accessed 2 December 2020]

Cornish, J. and Richardson, D. (2019) How can we tackle maths anxiety?
<https://www.tes.com/news/how-can-we-tackle-maths-anxiety>

Bjorge, Shannon; Hannah, Tracy; Rekstad, Peggy; and Pauly, Tara. (2017). The Behavioral Effects of Learning Outdoors

Higgins, P and Nicol, R (2002) in their book Outdoor Education: Authentic Learning in the context of Landscapes (Volume 2)

Russell, M. (2004) The importance of the affective domain in further education classroom culture. *Research in Post-Compulsory Education*, 9(2)

Amran, Saemah (2017) The Use of Humour in Mathematics Teaching and Its Relationship with Students' Concentration and Motivation

Henderson, S (2015) Laughter and Learning: Humor Boosts Retention (accessible via <https://www.edutopia.org/blog/laughter-learning-humor-boosts-retention-sarah-henderson>)

Referenced images and quotes

Davis, K. (1975) The Interpersonal Approach Is Not Enough. *Journal of Management Education*, 1(2).

Malone, K. (2008) Every Experience Matters: An evidence based research report on the role of learning outside the classroom for children's whole development from birth to eighteen years, Report commissioned by Farming and Countryside Education for UK Department Children, School and Families, Wollongong, Australia.

Metallidou, P. and Vlachou, A. (2007) Motivational beliefs, cognitive engagement, and achievement in language and mathematics in elementary school children. *International Journal of Psychology*, 42(1)

OFSTED (2008) Learning Outside the Classroom Manifesto

Shields, D. J. (2005) Teachers have the power to alleviate math anxiety.

Academic Exchange Quarterly, 9(3), 326-330.

Picture 1

https://www.plymouth.gov.uk/sites/default/files/Plymouth%20Report_2019.pdf,
Plymouth City Council, Plymouth Report, 2019

Picture 2 <https://padlet.com/c4me/f15>

Appendix 1 – Student Feedback Form Example

Accessible via <https://forms.gle/M2ay1ubFsNNjvL426>

Appendix 2 – Staff Feedback Form Example

Accessible via <https://forms.gle/eRjLzvA4GCw9ggtz8>

Appendix 3 – Lesson resources

These are all available on request - please contact mathscoe@cityplym.ac.uk