Improving the motivation and engagement of maths level 2 and GCSE re-sit students in FE Colleges by developing maths learning outside the traditional learning environment including outdoors and wider campus settings.

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Acknowledgements

OUR PARTNERS

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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

Our action research group at City College Plymouth have researched the effects of outside the traditional classroom learning on the 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
- 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 67 students across 2 FE sites, we found that 94% of students involved enjoyed the alternative practical maths lessons, 90% of students felt that other students in their cohort joined in more than usual for the alternative session, and 69% 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

Background

Why did we choose alternative learning environments?

Through the key themes highlighted in the Centres for Excellence in Maths programme, our focus point as a CfEM 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.

We reviewed the key principles for motivation and engagement and found striking links with the aims of learning outside the traditional classroom during our initial action research in 19/20:

- 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

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.

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.

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.

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Katie Fremlin - Project Manager Maths Centre for Excellence

Ben Ozanne - Maths Centre Coordinator and Coach

Research Development

Due to the current COVID 19 situation, we had to adapt and develop our action research along the way, this has meant that we have a smaller data set than originally anticipated. Despite this, based on our findings from 19/20 and 20/21, the results indicate maths learning outside the traditional classroom environment is a positive development in teaching and learning for post 16 GCSE mathematics.

In order to draw stronger conclusions and continue to develop good practice, we continued investigating maths learning outside the traditional classroom in 20/21, encompassing further lessons and activities within the SoW (scheme of work) and a wider data set across settings.

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, whose main programmes were highly practical-based vocations (Sport, Public Services, Hair/Beauty, Hospitality). Due to COVID, we did start out in September with 3 FE sites involved, however due to lockdowns and changing workload Exeter College unfortunately had to pull out of the research for this year. We continued the research at City College Plymouth and Piquet Barracks (partner unit).

We initially set out to produce 8 outside the classroom activities across Sept – March, based on mastery topics, however with the intermittent lockdowns we had to adapt and overcome and condense this down to 4 sessions.

We set out to develop an inhouse diagnostic test, using various elements including Likert Scales, to assess ways in which our students felt they learnt best, self-assessment of their confidence levels and skill set, and maths anxiety self-assessment based questions. Following each practical maths activity, we devised methods to gather student and lecturer feedback.

Our key principal focus this year sat under motivation and engagement with “Teaching in ways sympathetic to students’ usual ways of working in other areas of their programme.”

Our initial research objectives were;

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.

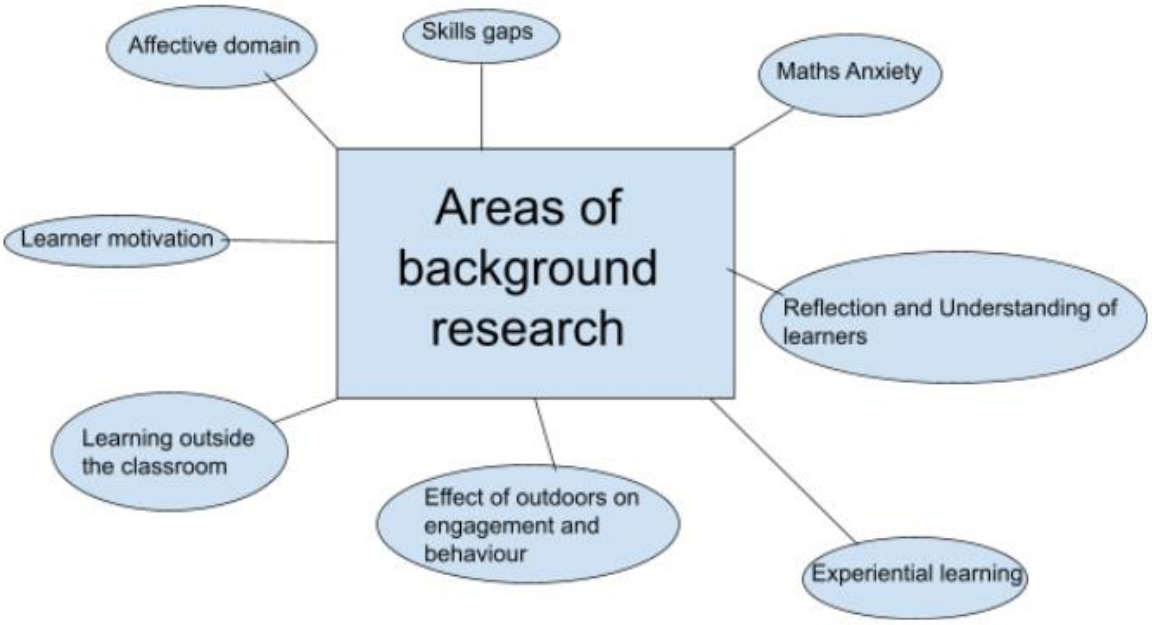
When we set out, we wanted to tackle and approach the new COVID normal through practical outside the classroom sessions supporting with social distancing measures and allowing learning outside in the open as often as possible. In many ways we predicted this would also support with students that may have heightened anxiety during the current situation, removing the confines of the traditional classroom literally and metaphorically. As an ongoing development alongside our research, we also developed practical maths activities that could be completed individually at home by students and our network community to support communication and engagement during the remote working periods.

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, 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. To aid with this, we also sort support from the expertise within the team. Our own research was backed up and complemented by learning from our previous action research as well as shared best practice from the 21 CfEMs and feedback from students, staff, SLT, network partners and wider community.

We also debated the relevance of some of the material as a team to agree on a set suite of literature moving forward.

As an ARG (Action Research Group) we began by highlighting the areas we wanted to research and how they would support the creation of the project.



For the initial diagnostic, we knew that maths anxiety was a prevalent feature and that we needed to have a clear measure of for our students' maths anxiety levels. When researching we came across some great self-diagnosis examples in an article called Do You Have Math Anxiety? A Self Test by the University of Central Missouri which includes an example self-assessment for maths anxiety, and therefore influenced the design of our initial diagnostic assessment and the selection of anxiety scale questions put to students. The article references "Coping with Math Anxiety," by B. Sidney Smith, and includes coping mechanisms and solution focussed practice explanation.

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 byBjorge,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.

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 this year, 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 we want to progress this at FE level.

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 4 practical outside the classroom maths lessons across the academic year and SoW and was informed bysome 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:

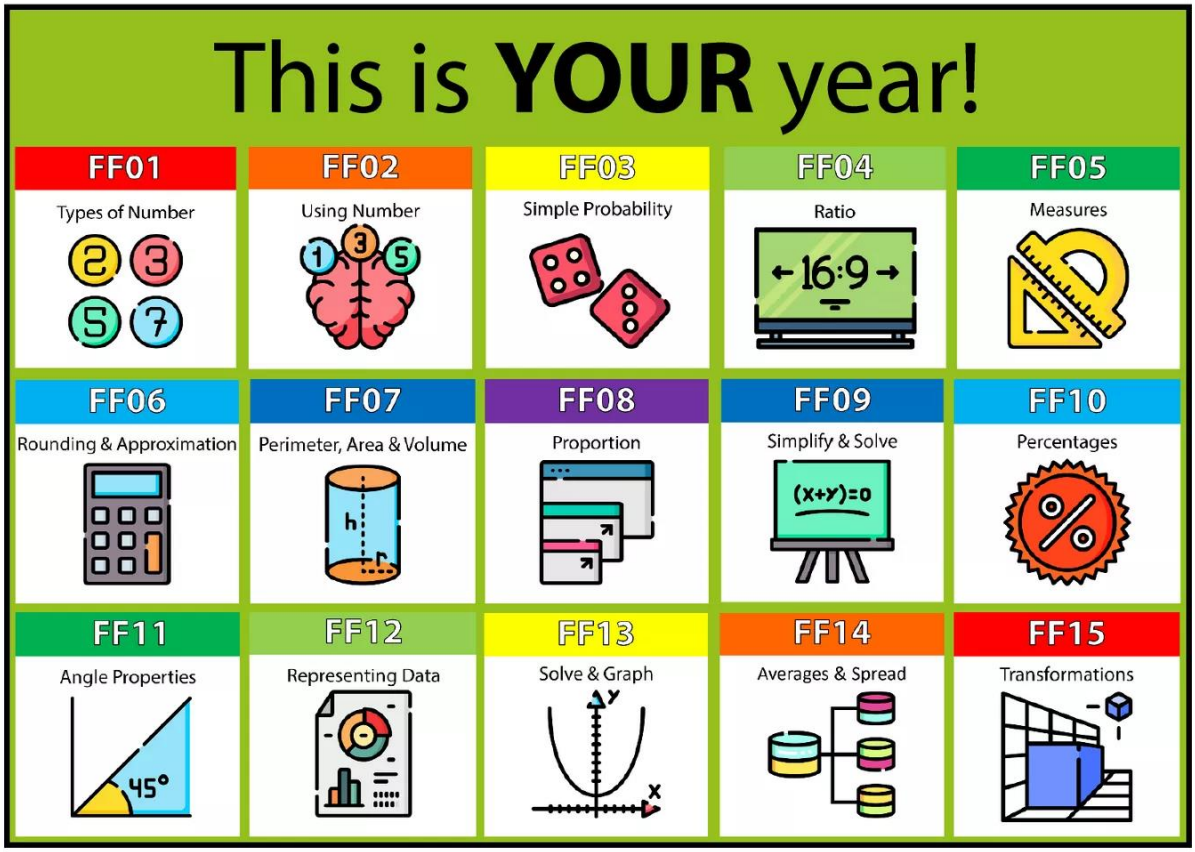
-ensure that their curriculum planning includes sufficient well-structured opportunities for all learners to engage in learning outside the classroom as a key, integrated element of their experience

-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 wanted to research more on post 16 maths mastery and what underpinning maths concepts we could incorporate into practical activities to boost

learner understanding. To support this, we were inspired by the work of fellow CfEM Grimsby College and their lead Emma Bell who created the Focussed 15 concept (see picture 3).



(Picture 3)

Method

Our question: Improving the motivation and engagement of maths Level 2 and GCSE re-sit students in FE Colleges by developing maths learning outside the traditional learning environment including outdoors and wider campus settings.

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. The students took part in all 4 sessions and therefore built ongoing relationships with the ARG team.

We devised an initial diagnostic assessment (appendix 1) which we used for both our action research projects, created to get to know students, find out how they feel they learn best, what characteristics they feel they have, their maths anxiety levels and their goals for the future. This gave us an overview of the students involved and initiated that contact and participation in the research.

To measure students' cognitive and behavioural engagement we chose to consolidate 2 pieces of evidence: an anonymous student survey (appendix 3) and a staff interview (appendix 4) 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 4 practical maths sessions as an ARG we had virtual 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, bearings, area, data collection and analysis, ratios/proportion and statistics whilst being aware that all these areas would consolidate basic maths skills such as addition and subtraction.

As we shared ideas, it was great to see the passion and enthusiasm that thinking "outside the box" creates! We initially looked at 8 sessions across the SoW, however due to COVID restrictions and lockdown periods, we had to reduce this to 4 practical sessions, as follows;

- Session 1 - Campus Orienteering

Our flagship ALE session, this formed our action research in 19/20 and the positive suggestions from this supported us to choose this as session 1 delivered in Oct/Nov 2020. The session incorporates data collection, bearings and problem solving on an outdoors orienteering tour of the campus.

- Session 2 - The perfect squash and smoothies!

A creative session covering ratios, percentages and measurements, which can be carried out in hospitality settings on a College campus or any environment with access to electricity. An extension of this activity was to use a smoothie bike which removes the need for electricity, but this wasn't possible in this cycle.

- Session 3 - Running Speeds

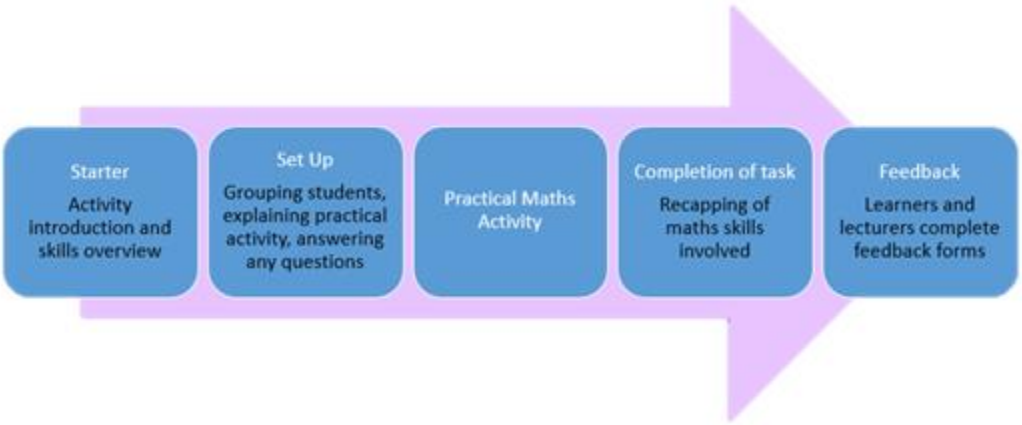
Using well known athletes and sporting events to calculate and analyse racing speeds, including getting students up and out of the classroom to actively measure their own speeds.

- Session 4 - 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!

See Appendix 2 for Lesson links/resources.

Session structure:



Over the course of the year, we completed the sessions with students from our main College campus and from 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.

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.

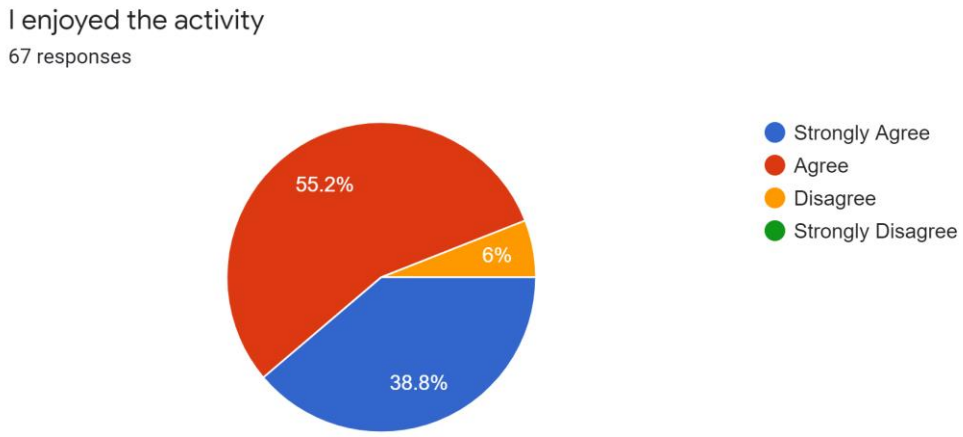
Due to COVID, we planned in a way that we could adapt the sessions to a virtual/online environment, however as a team we were striving for the opportunity to deliver face to face in authentic alternative environments as we feel this was so important for the essence of the research. Luckily, we were able to hold fire on 3 of the sessions and then deliver these on return to campus in May 2021. This was not the ideal spacing, and for a "normal" year we would structure the lessons periodically into the SoW at monthly intervals.

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.

Results and Discussion

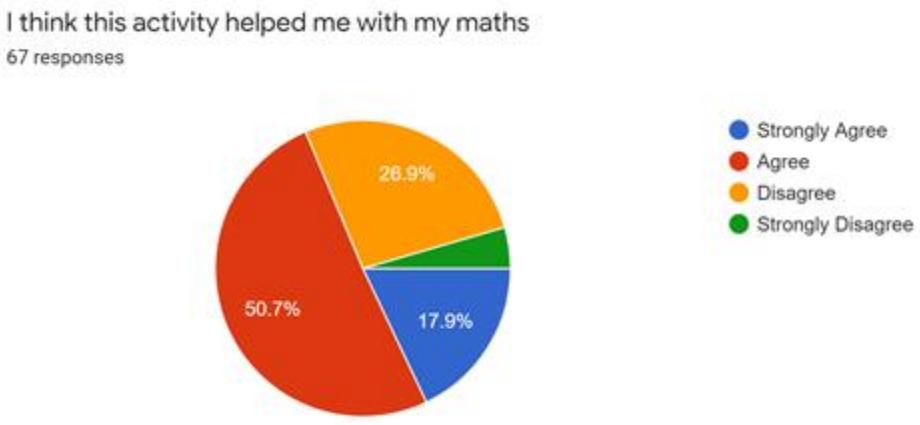
To begin in our initial eyeballing of the data, we were pleased to see that 94% of learners enjoyed the alternative sessions because enjoyment is a vital component of motivation and engagement.

Figure 1.



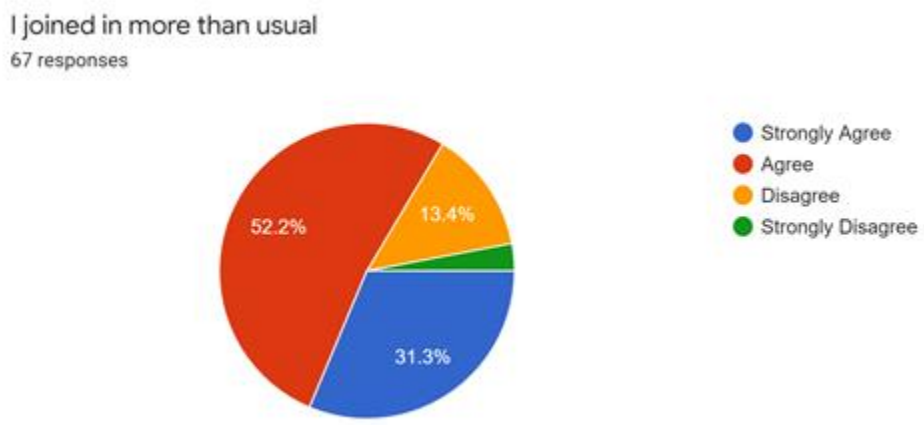
The student survey was designed to collect evidence of both cognitive and behavioural engagement. Overall, the results were very positive with students showing cognitive engagement: with 69% of students answering either agree or strongly agree to the question of whether the activity helped them with their maths.

Figure 2.



In terms of behavioural engagement, 84% of students agreed or strongly agreed that they joined in the task more than usual. This suggests that the students are increasing in confidence and autonomy within their maths sessions, and feeling more motivated to learn.

Figure 3.



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) with the following written comments from them;

Figure 4.

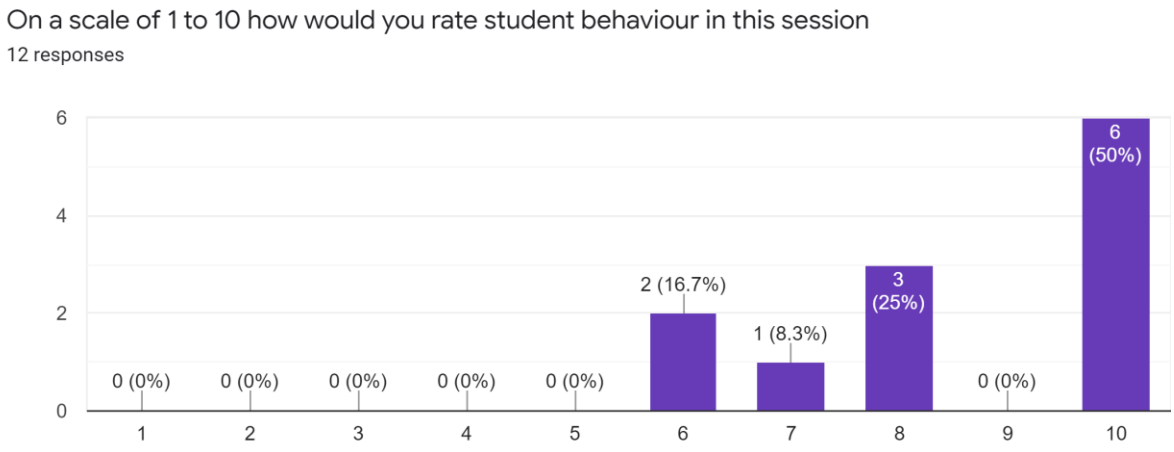


Figure 5.

Is this behaviour different from usual maths lessons for the group? If so, in what way?
In this session the students were better than usual.
More focussed than usual
It was slightly better, but could have been better
Different that they engaged more, behaviour is normally always good.
Willing to work more than usual, distracted but did the work.
This group generally has really good behaviour anyway, but this was repeated with this activity.
Yes, more focused and determined to achieve the answer.
The students' behaviour was much better, they were normally good but this time they were much better
MUCH more engaged than usual.
Students do struggle with focus normally, however the quieter members of the group seemed to get into the activity and engage more
The students' behaviour was different as they were more engaged for longer than they are normally.
No

From a lecturer point of view, in the context of cognitive engagement teachers gave a score of between 6-10 (positive Likert scale) for students' interaction with them, and the majority of feedback indicated students were more autonomous, taking ownership for their learning within the session.

Figure 6.

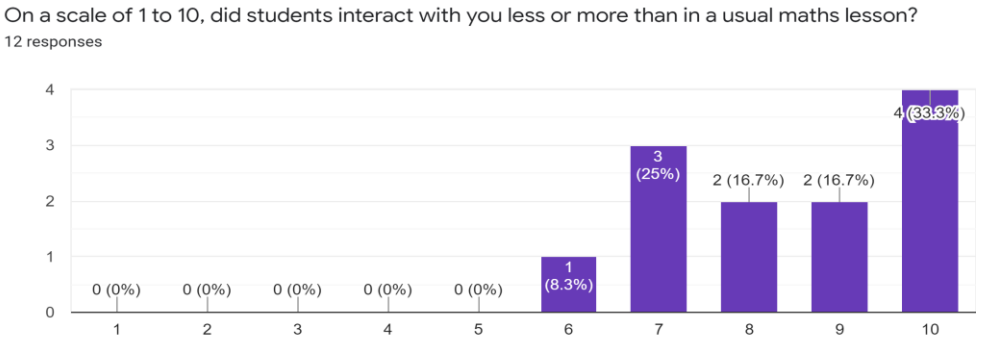


Figure 7.

Did you feel the students were more autonomous in the lesson?

Yes, the students worked out the ingredients and created their own drinks

Surprising that some students really engaged and some did just follow the others.

Yes, they were all fully doing the work on their own

Some were but not all

Yes, I think they were

In most cases yes, there were some that needed a little help with the compasses.

The students were all working on their own and enjoying the work

No

Slightly more, they were doing more work than usual but still needed a little help here and there.

Yes, but I think if we had not checked on their progress some would have given up or not tried to find the rest of the bearings.

Discussion

Due to the current COVID 19 situation our action research was completed with a relatively small data set from both sites (delivery of sessions was inhibited by lockdown periods), however our ongoing results from 2019 strongly indicate that maths learning outside the classroom is a positive development in teaching and learning for post 16 GCSE mathematics.

From our data set of 67 students across 2 FE sites, we found that 94% of students involved enjoyed the alternative practical maths lessons, 89.6% of students felt that other students in their cohort joined in more than usual for the alternative session, and 69% 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 when we set out in Summer 2020;

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.

Through the ongoing COVID situation, it has not been possible to fully explore all the objectives, and with a larger data set we would be able to draw stronger conclusions. We would have liked to work with a larger amount of students from various FE sites to be able to explore whether there are differences in levels of engagement by learner characteristics (Age, Gender, SEN, Functional Skills Level 2, GCSE Grade 3 etc.), however, due to the nature of this year we were not able to delve into this as widely as wanted, and this will be a point to consider in our research projects for 21/22. We would also have liked to have held ALE student forums face to face to gather feedback, however this was not possible at points throughout the year. With a wider data set we would be able to explore our diagnostic process more and for next year's research we will develop this further. In September, we were due to start the research at Exeter College also, however due to the ongoing COVID situation they unfortunately had to step back, but will be resuming their action research with us in 21/22.

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; the COVID situation, 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 and Piquet Barracks 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 indicate positive observations on student behaviour, and this will be monitored throughout the continuation of our research as it evolves in 21/22. As a musing from our data, we are beginning to 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.

Timescale was a limiting factor this year for our research especially throughout the periodic lockdowns, so our timeframe to collect data was limited and led to us having to reduce the schedule of alternative sessions from 8 to 4. We planned during the pandemic in a way that we could adapt the sessions to a virtual/online environment, however as a team we were striving for the opportunity to deliver face to face in authentic alternative environments as we feel this was so important for the essence of the research. We opted to hold fire on 3 of the sessions and deliver these on return to campus in May 2021. Although this was not the ideal spacing, and for a "normal" year we would structure the lessons periodically into the SoW at monthly interval, we felt this was the best option for an authentic experience for learners and lecturers.

For this year we extended the data collection to Level 2 functional skills students also, which allowed us to work with our partner site Piquet Barracks.

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.

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. 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 for 21/22. As a CfEM, we continually create digital resources and support materials for our students and this ensured continued engagement throughout the lockdowns in 20/21. We often explore practical maths activities through these support materials and have found this resonates with learners of all ages.

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, with our mission being to improve the motivation and engagement of maths Level 2 and GCSE re-sit students in FE Colleges by developing maths learning outside the traditional learning environment including outdoors and wider campus settings.

The overriding aim of our research 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. Despite the impact of Covid and the effect this had on the number of sessions, scheduling and delivery, 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. Developing our research for next year, 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

- Continue research with an increased data set to be able to draw stronger conclusions
- Continue to develop diagnostic assessment tools so that learner groups can be compared more extensively
- Develop timeframes/schedules to spread 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
- Further develop the research of vocational focussed embedding of maths and contextualisation through practical maths activities
- Further develop a positive maths cross college culture and share this good practice

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Background research

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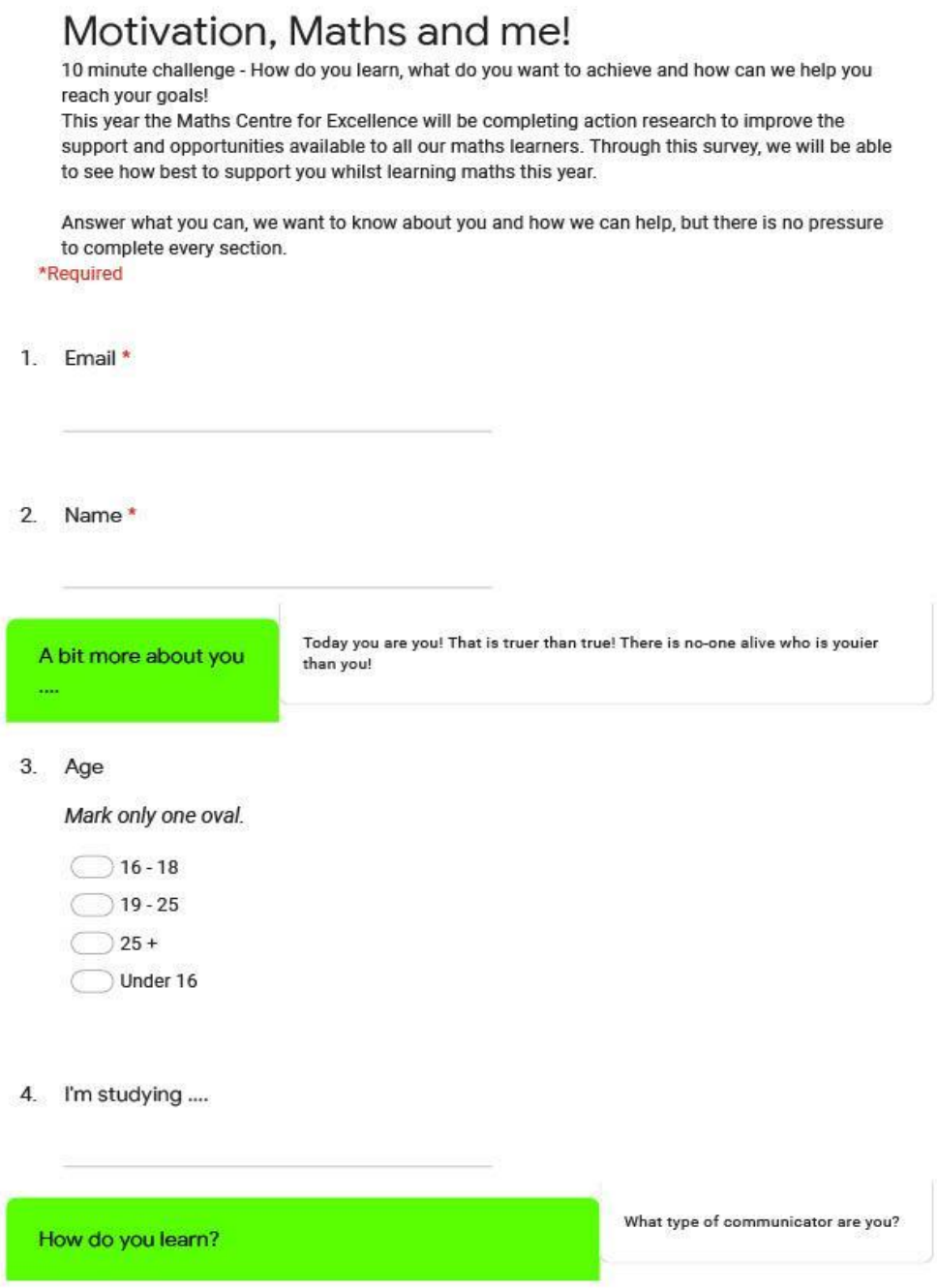
Picture 1 https://www.lotc.org.uk/history-resource-packs/

Picture 2 https://www.plymouth.gov.uk/sites/default/files/Plymouth%20Report_2019.pdf, Plymouth City Council, Plymouth Report, 2019

Picture 3 https://padlet.com/c4me/f15

Appendices

Appendix 1 Student Initial Diagnostic/Survey Motivation, Maths and Me



Motivation, Maths and me!

10 minute challenge - How do you learn, what do you want to achieve and how can we help you reach your goals!
This year the Maths Centre for Excellence will be completing action research to improve the support and opportunities available to all our maths learners. Through this survey, we will be able to see how best to support you whilst learning maths this year.

Answer what you can, we want to know about you and how we can help, but there is no pressure to complete every section.

*Required

1. Email *

2. Name *

A bit more about you ....

Today you are you! That is truer than true! There is no-one alive who is youier than you!

3. Age

Mark only one oval.

- 16 - 18
- 19 - 25
- 25 +
- Under 16

4. I'm studying ....

How do you learn?

What type of communicator are you?

5. Choose 3 of the options below which best describe you;

Tick all that apply.

- [ ] Happy to do unplanned things
- [ ] Straight to the point
- [ ] Imaginative
- [ ] Find it easy to make decisions
- [ ] Relaxed and patient
- [ ] Charismatic - do you have the X Factor?
- [ ] Nervous, unsure of situations
- [ ] Understanding
- [ ] Empathetic - aware and understanding of peoples emotions
- [ ] Creative
- [ ] Energetic - full of beans!
- [ ] Organised and like plans

6. When approaching a situation, do you like? (Pick 1)

Mark only one oval.

- ◯ Facts and logic, policies, planning, control over chaos, instructions
- ◯ Objectives and results, productivity, competition, taking charge and making firm decisions
- ◯ Change and creativity, friendly and optimistic, big ideas and conceptualisation, adapting
- ◯ Teamwork, building relationships, being nurturing and sensitive, listening to others

7. When working on a coursework project, do you prefer

Mark only one oval.

- ◯ Working in a small group
- ◯ Working on your own

8. Do you prefer

Mark only one oval.

- ◯ In person lessons
- ◯ Online live lessons
- ◯ Pre-recorded content so that I can work at my own pace

9. How would you rate your IT skills

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very confident	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very confid

How do you feel about maths?

How do you feel about the following scenarios? 10 means you feel really comfortable ranging down to 1 meaning you feel very anxious.

10. Studying for a maths qualification at College

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very anxious	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Completely con

11. Walking into a maths lesson

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very anxious	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Completely con

12. Watching a teacher work on a maths equation on the board

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very anxious	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Completely con

13. Being given a surprise maths quiz in the lesson

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very anxious	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Completely con

14. Being asked to explain a maths formula in class

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very anxious	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Completely con

15. Listening to another student explain a maths formula

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very anxious	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Completely con

Where do you want to go?

What is the perfect future for you? :)

16. What goal do you want to achieve this year?

17. Where would you like to be in 5 years time?

18. Is there anything you feel is a barrier to these goals? How can you achieve it?

Appendix 2 Session 1 to 4

These are all available on request - please contact mathscoe@cityplym.ac.uk or request access to the following drive https://drive.google.com/drive/folders/1z7h_ABDJAJ6uC7zAV-pw8AP1B95LlDuq?usp=sharing

Appendix 3 Student Feedback Form

Learning outside the traditional classroom

Having completed today's maths activity please answer these questions as honestly as possible with your feedback. These questionnaires are anonymous.

*Required

1. I attend

Mark only one oval.

- ◯ City College Plymouth
- ◯ Exeter College
- ◯ Cornwall College Group
- ◯ Other
- ◯ Piquet Barracks - CCP

2. Date and time of lesson

_____

3. Which lesson did you complete *

Mark only one oval.

- ◯ Campus Orienteering
- ◯ Murder Mystery
- ◯ Mocktails and Smoothies
- ◯ Speed Analysis
- ◯ Escape Room
- ◯ Other - Selection of remote maths activities

4. If other, please describe the activity below

_____

5. I was happy when my teacher said we would do this maths activity *

Mark only one oval.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly Disagree

6. I enjoyed the activity *

Mark only one oval.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly Disagree

7. I preferred today's activity to my normal classroom lessons *

Mark only one oval.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly Disagree

8. I think this activity helped me with my maths *

Mark only one oval.

- ◯ Strongly Agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly Disagree

9. The other students joined in more than usual *

Mark only one oval.

- Strongly Agree
- Agree
- Disagree
- Strongly Disagree

10. I joined in more than usual *

Mark only one oval.

- Strongly Agree
- Agree
- Disagree
- Strongly Disagree

11. On a scale of 1 to 10, how confident are you feeling about your maths qualification? (1 being not at all and 10 being super confident)

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not at all											Super confident

Appendix 4 - Staff Interview Form

Staff Interview following AR session

Staff feedback

1. Session Title

   Mark only one oval.

   - ◯ Campus Orienteering
   - ◯ Murder Mystery
   - ◯ Mocktails and Smoothies
   - ◯ Speed Analysis
   - ◯ Escape Room
   - ◯ Other - Selection of remote maths activities

2. If other, please specify which activity

   _____

3. Date and time of session

   _____

4. Cohort

   _____

5. As the tutor, did you enjoy delivering this alternative session?

   _____

6. On a scale of 1 to 10 how would you rate student behaviour in this session

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Excellent

7. Is this behaviour different from usual maths lessons for the group? If so, in what way?

_____

8. On a scale of 1 to 10, did students interact with you less or more than in a usual maths lesson?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Less	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	More

9. How do you feel the students found the lesson?

_____

10. Did you feel the students were more autonomous in the lesson?

_____

_____

_____

_____

_____

11. Would you feel happy delivering this session again?

_____