CENTRES FOR EXCELLENCE IN MATHS

Evaluating the impact of a responsive approach to teaching mathematics in Further Education.

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OUR PARTNERS

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

FUNDED BY

Department for Education

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.

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Introduction

About the college

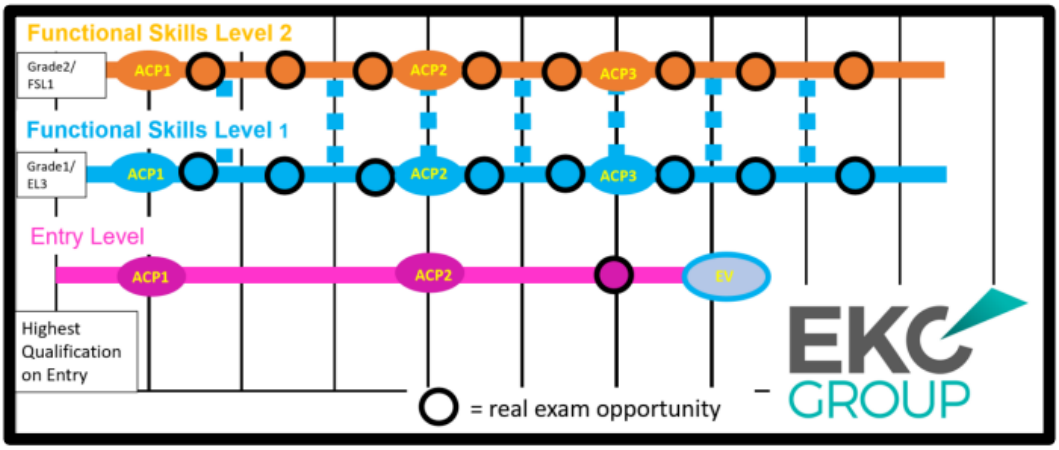
The EKC Group is a family of six colleges on the southeast coast of Kent. In total, we have around 70 mathematics teachers and 12,000 learners across the group. Our action research group consisted of representatives from each college within the EKC Group as well as our network partners: Activate Learning North Kent College and MidKent College.

EKC Group Mathematics Provision

The EKC Group offers the following pathways for mathematics students: Functional Skills Mathematics (Pearson), Entry level, level 1 and level 2 and GCSE resits. Students with a grade 3 or above attend GCSE resits classes and those with a grade 2 or below are placed the Functional Skills program.

The Functional Skills Entry and Level 1 provisions are mainly taught within curriculum areas by vocational tutors. Functional Skills Level 2 and GCSE resit classes are taught by specialist maths tutors.

There are two study routes for mathematics learners within the EKC Group: the full year option or a fast-track route (for Functional skills students) / intensive route (for GCSE students). The fast-track/intensive option route is offered to motivated students or students who are strong on entry, for example, returning students who are only a few marks away from passing a mathematical qualification.



Research Focus

The academic year 2021-22 saw lessons resuming normally as COVID-19 rules and guidelines were relaxed and eventually removed. We knew that it was always going to be a challenging year as several reports and studies have shown.

In December 2021, the DFE reported that "there are big gaps in learners' English and maths and that the transition from lockdown back to face-to-face learning had been difficult for some learners. [] there were high levels of concern about learners' mental health. Several providers had experienced high staff turnover, including redeployment.[1]

There was already evidence that the attainment gap was beginning to widen before the pandemic (Hutchinson, Reader, & Akhal, 2020) and this worsened after the pandemic.

For us, at the EKC Group, it was evident that we had to take into consideration the widening gaps in numeracy and adapt our practice. We decided to review our teaching, learning and assessment strategies, focus on a responsive approach to teaching to achieve more favourable outcomes.

The overarching aim of the EKC Group's 2021-22 QIP was to improve the quality of teaching, learning and assessment (TLA) and the results of the Functional Skills and GCSE resits (mathematics and English) provision. There was also a clear focus on upskilling mathematics teachers across the Group as well as improving the overall students' learning experience.

Bell (1993) highlights that, adults with basic numeracy skills, earn higher wages and are more likely to be employed than those who fail to master basic quantitative skills. This has wealth, health and well-being implications for adults throughout their lives. It also has an impact on the UK economy. The large increase in students requiring mathematics creates increased demand for teachers capable of teaching the subject. Ofsted identified difficulties in recruiting and retaining skilled and experienced teachers. The implication is a need to develop staff subject knowledge and skills rapidly.

The EKC Group tried to embed a diagnostic approach to teaching mathematics since the start of the Centre for Excellence in Maths Project in 2019. However, the COVID pandemic disrupted its implementation.

A smaller scaled action research project in 2020-21 showed that this pedagogical approach to mathematic lessons in Further Education works. In her final report, Sarah Morgan (*ETF*, June 2021) states that: "Early indications are that diagnostic teaching can be a very successful strategy and have a positive effect on functional skills outcomes."

Therefore, it was evident that a responsive approach to teaching, if delivered efficiently, can have a strong impact on students' learning experience and outcomes. The EKC's mathematics collaborative resources uses a responsive approach to teaching, learning and assessment and therefore it was importance and imperative to assess whether this was the best way forward.

[1] Education recovery in further education and skills providers: autumn - GOV.UK (www.gov.uk)

Elements of a responsive approach at the EKC Group

The focus of the first year (2020-21) of the EKC's CFEM action research project was the creation, embedding and sustainability of collaborative mathematics resources. These resources embedded elements of a mastery approach such as:

1. Initial assessments
2. Entry and exit tickets to determine students starting and ending points in lessons (Appendix The answers to questions in the Entry ticket allow teachers to make a judgement on their starting point for each student in the lessons. Answers to the Exit tickets allow teachers to efficiently assess students' understand and progress at the end of the lessons.
3. Diagnostic questions to identify common misconceptions and encourage deeper understanding of core concepts
4. Concrete, pictorial and abstract (CPA) approach to core topics
5. Gap analysis after assessment checkpoint using a Question Level Analysis sheet (Appendix B)
6. Digital platforms such as CENTURY Tech and Hegarty maths for independent learning tasks and diagnostic tasks

Literature Review

What is '*responsive teaching'*?

There are several schools of thoughts when it comes to a responsive approach to teaching. Paul Black and Dylan Wiliam suggest that responsiveness to teaching is about *formative assessment* (Inside the black box: raising standards through classroom assessment,1997). According to Black and Wiliam,

> "The main plank of our argument is that standards can be raised only by changes that are put into direct effect by teachers and pupils in classrooms. There is a body of firm evidence that formative assessment is an essential component of classroom work and that its development can raise standards of achievement. We know of no other way of raising standards for which such a strong prima facie case can be made."

They further argue that "Practice in a classroom is formative to the extent that evidence about student achievement is **elicited, interpreted and used** by **teachers, learners,** or their **peers**, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited." (Black & Wiliam, 2009).

The purpose of formative assessment is to **gather information** on student understanding and use this to **make modifications** to teaching and learning activities, within the lesson or between lessons, in a way that is **beneficial to student learning**. (Dalby & Swan, 2018).

However, Harry Fletcher-Wood argues that 'cognitive science came to seem increasingly important to responsive teaching.' He describes *responsive teaching* as a combination of formative assessment and cognitive science but affirms that Harry Rei's definition of the term is much more apt. The latter describes responsive teaching as the feeling that we are interacting with someone who is: "cognizant of, sensitive to, and behaviorally supportive of the self (2007, p.9)"

So, his working definition of *responsive teaching* (Blog, 2018) is:

1. Setting clear goals and planning learning carefully
2. Identifying what students have understood and where they are struggling
3. Responding, adapting our teaching to support students to do better.

Responsive approach to mathematics in Further Education

Evidently, most pedagogical research on responsive teaching is geared towards the primary and secondary sector.

Therefore, when considering the most effective responsive model, we drew on the work of Noyes and Dalby (2015), who are argue that "mathematics teachers identify a need for context-specific variation in teaching, using different adaptive pedagogies and resources to meet students' needs. This includes adaptations designed to engage students, differentiate, contextualise, connect to vocational programmes, align with different vocational pedagogies and make effective use of diagnostic assessment."

Their work were influential towards our design of an effective responsive model, especially when contextualising the teaching, learning and assessment.

Appendix A

Example of an Entry Ticket when teaching Fraction of an amount

Name: _____ **ENTRY TICKET**

Calculate $\frac{1}{5} of\ £500$	Calculate $\frac{4}{5} of\ £500$
Calculate $\frac{1}{5}$ of a kilogram?	Katy pays £10 a week for a train ticket, the price increase by $\frac{1}{5}$, what is the new price?

Exit Ticket for the same lesson

Name: _____ **EXIT TICKET**

Jay gets time and a half on a Sunday. How much does he earn per hour on a Sunday?	Jay saves $\frac{2}{5}$ of his weekly wage. How much does he save?
How much does Jay earn over 4 Sundays?	Jay's salary increases by $\frac{1}{4}$? How much does he earn in one day?

Jay is a builder and earns £20 per hour and works 6 hours a day, 5 days a week.

Methods

We targeted groups of students from each college and stratified them by pathways (sub-groups) – GCSE Maths Re-sits and Functional Skills maths Level 1/Level 2.

We felt that it was important to include students on the Functional Skills pathway because they are a big and important cohort in the Further Education sector.

Of the 69 maths teachers across the EKC Group, 8 teachers (Mathematics specialists and vocational teachers) were involved for this Action Research.

Of the 280 cohorts of 16-19 students taught by these teachers, 3 cohorts per college were selected at random (9 across the group).

Of the 12,000 EKC students, approximately 350 maths students (across the Group, based on 8 teachers working with 3 cohorts of students) were involved in the Action research.

Our network partners, Activate Learning and MidKent college collected data from a sample of 30 students each.

Data Collection Instruments

During the first cycle, we conducted the first survey, via Microsoft Forms, to gather to gage teachers' and learners' initial perception of responsive teaching and diagnostic tools.

Our second survey, via Microsoft Forms, was done to review how maths teachers and learners were using diagnostic tools in their classroom. The focus was on the following tools:

1. Question Level Analysis form
2. Entry and Exit tickets
3. Exam-style questions.

Whilst we looked at CENTURY and Hegarty data, we did not go into much detail as we had diagnostic tools in our 2021-22 action research. (East-Kent-College-Components-of-an-effective-digital-maths-provision.pdf (et-foundation.co.uk))

We also collected data from each assessment Checkpoint– October 2021, January 2022 and April 2022.

We also carried out regular learning walks (in line with the group frequency and policy) as well as a couple of mock OFSTED 'Deep Dive' sessions to ascertain whether a responsive approach was standard across all six EKC colleges.

In the second cycle, once we identified areas of strengths and weaknesses, we established a continuous development cycle, which included team-teaching sessions, peer observations as well as 'Teaching Learning and Assessment Grab and Gos' to provide short but targeted professional development on elements of responsive teaching.

Attendance data was also reviewed and analysed because we wanted to see the correlation between an individualised approach through responsive teaching and motivation and engagement. We hypothesised that if maths lessons were personalised, students are more likely to attend all their maths lessons as they feel valued.

Please note that we will not be sharing Assessment and Attendance data as appendices; the results have been anonymised to prevent bias.

Network Partners

MidKent college reviewed and restructured their mathematics offers.

In previous years at MidKent College, Functional Skills (FS) maths was offered as a qualification to lower achievers, they would be able to achieve Entry 3 or Level 1 maths and progressing students would then sit GCSE the following year.

It was identified that there was a need for a change in curriculum design to bridge the learning gap between Entry 3 and Level 1 to prepare students for GCSE. In March 2021, after college closure, only 23% students were assessed as ready to sit the level 1 maths exam and only 11% of students passed the Level 1 maths exam by the end of the academic year (4748 new spec launched in September 19 and delivered during the pandemic). It became questionable as to whether Level 1 FS maths qualification was fit for purpose for 16-19's. FS Maths (4748) combined E3 and L1 results were 27% pass.

Even pre-pandemic, under the legacy specification (3748) combined E3 and L1 results were low at 58% pass. The significant drop from the 3748-pass rate to the 4748-pass is in part due to FS English and maths being the only qualifications within the FE sector that was sat during the pandemic rather than using CAG, TAG, QTAG or adaptation.

Tutor performance for both qualifications was consistent across all groups leading us to conclude the difficulty lay also with the qualification itself; this is supported by the national statistics and experience.

The first stage of change in curriculum design was implemented in September 2021. The English and Maths department no longer offer a FS qualification to students, instead, students that enrol in College with a grade 2 or below are enrolled onto a year 1 GCSE programme, with an aim to sit GCSE exam in June and increase their grade by a minimum of 1 level.

Existing Functional skills tutors started teaching year 1 of the GCSE syllabus.

Results and Discussion

Teachers' perception of responsive teaching.

41 teachers responded to our survey in the first cycle, prior to any form of training on the topic. Appendix C shows the detailed answer of each teacher; however, it was obvious that most of the teachers at the EKC had a good understanding of what responsive teaching *was.*

One respondent said that '*…responsive teaching is making decisions within the classroom moment by moment, usually based on the behaviour or receptiveness of a student. This can then inform the next steps in teaching.'*

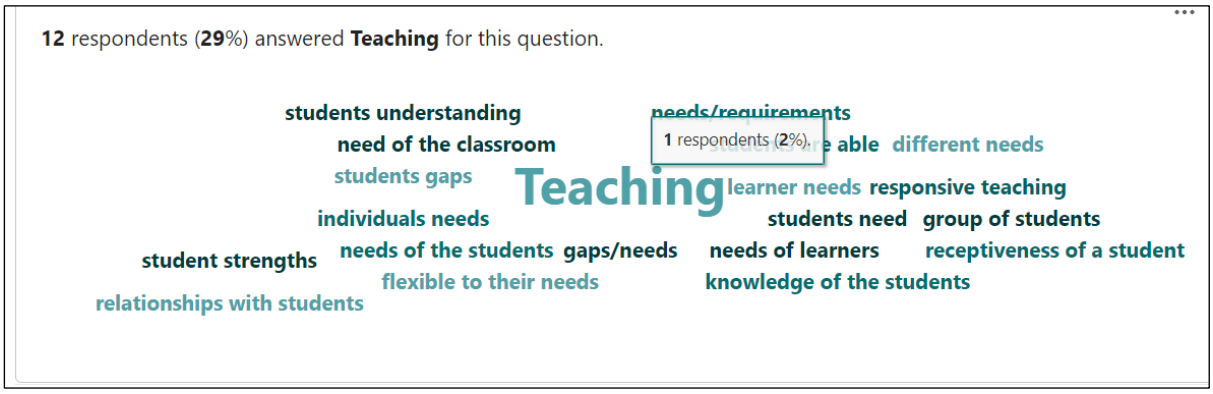


Figure 1

It was reassuring to hear such strong responses, especially from teachers who had been previously involved in the CFEM project.

One teacher said that responsive teaching is about '*Identifying gaps in knowledge/skills through assessment. Planning to according to question level analysis. Use of entry and exit tickets and question level analysis to inform planning. Students responding to individual goals set by the teacher - students must know how they can improve.'*

Diagnostic tools according to teachers

When asked what diagnostic tools they were more likely to use in their lessons, they showed a clear understanding of a variety of pedagogical tools to support with their delivery, as illustrated in the diagram below

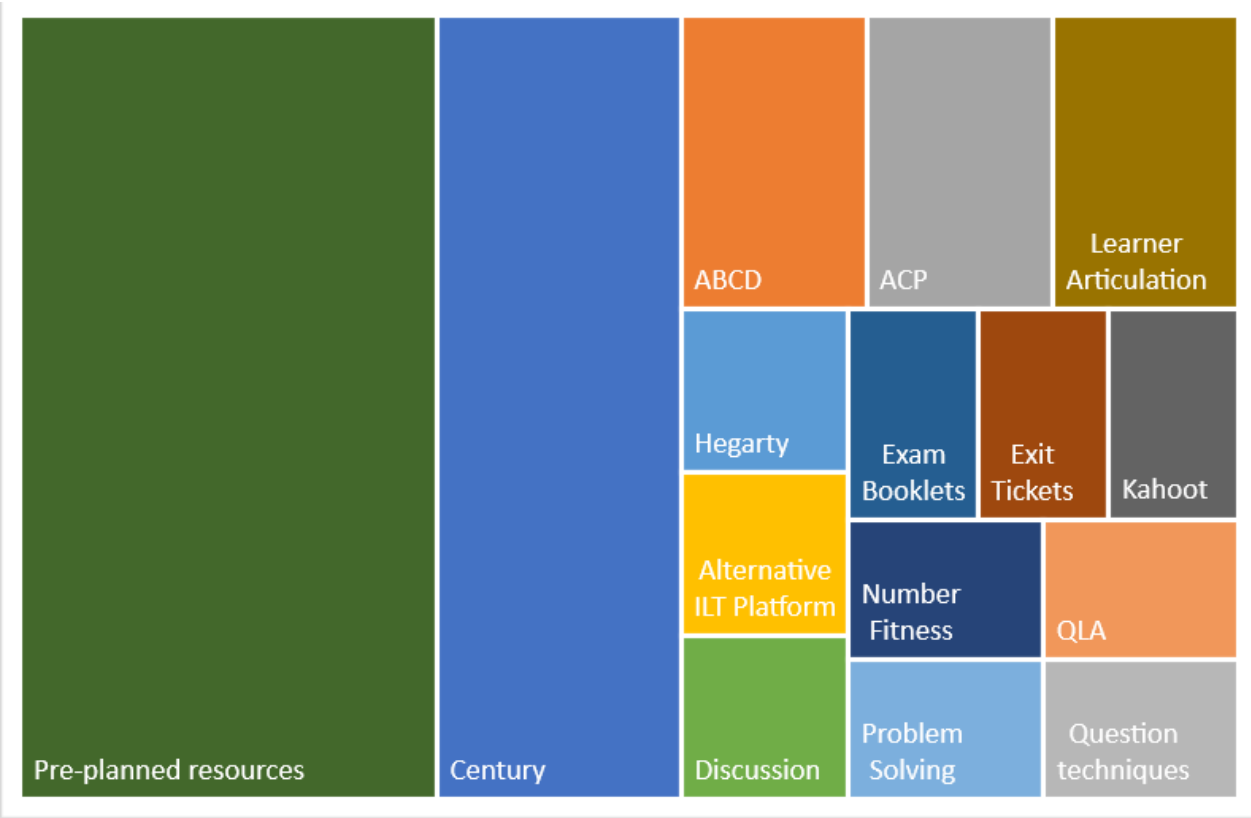


Figure 2

Feedback from teachers:

Teacher A: “Students are more engaged because they are learning things rather than recapping the topics they already know.”

Teacher B: “100% on the students that have sat the E3 test.”

Teacher C: “My responsive approach has resulted in all learners being entered into their E3 exam in February. Feedback has been positive with learners appearing to enjoy lessons.”

Teacher D: “I feel that being able to identify straight away if a student is struggling with a concept allows the teaching to be more dynamic and relating directly to what is required rather than trawling through a long-winded PowerPoint.”

Teacher E: “It has cutdown wastage of time spent covering topics learners are already well experienced with, allowing me to focus our resources i.e. time, paper, staff on subjects which will challenge, engage and hopefully best improve overall ability and confidence in specific areas crucial to achievement.”

Learners' responses

There were 215 respondents taking part in the first survey. Figure 3 shows the breakdown by pathways.

FS L1	FS L2	GCSE
47	86	82

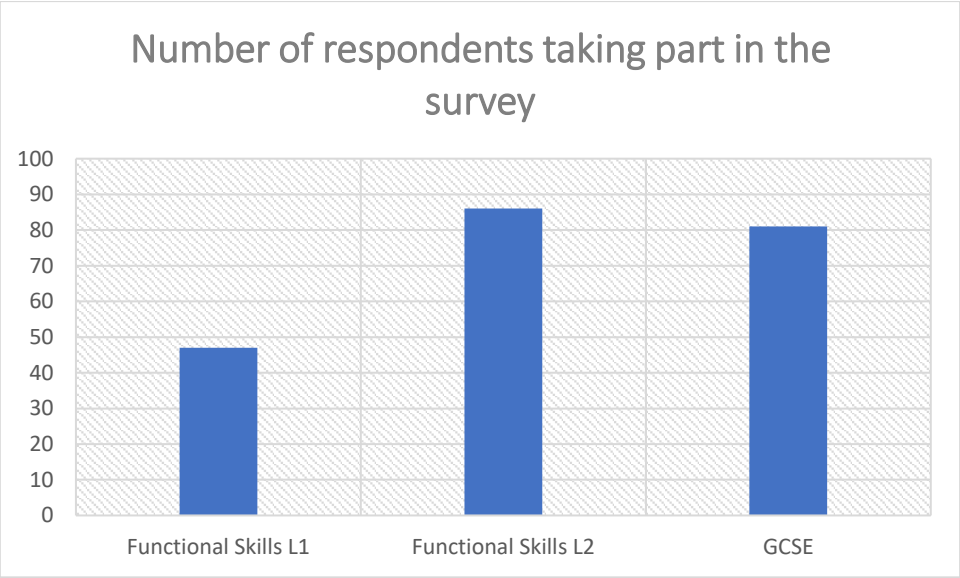


Figure 3

Figure 4 breaks down the data by college.

Ashford College	39
Broadstairs College	37
Canterbury College	54
Dover College	38
Folkestone College	19
Sheppey College	28

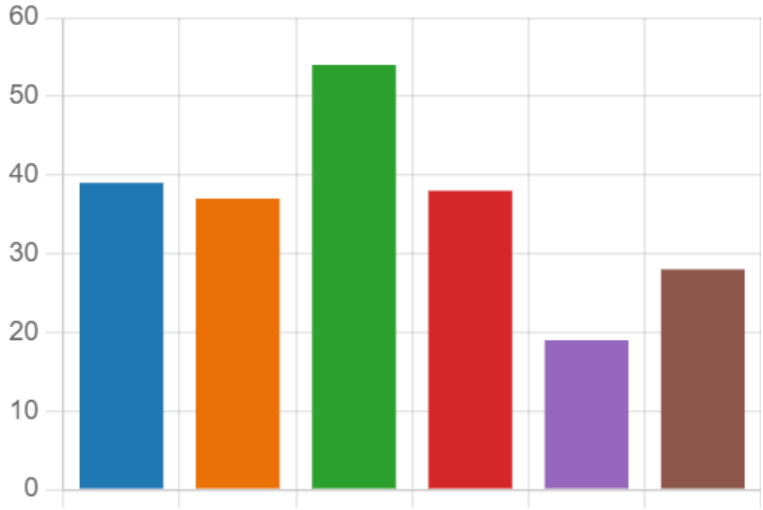


Figure 4

Question Level Analysis Questionnaire (QLA)

We believe that this is the most important diagnostic tool for the EKC's responsive approach to work.

Teachers complete this sheet (Microsoft Excel), as illustrated in figure 5, after the initial assessment and each assessment checkpoint to ascertain students' gaps, especially within the core curriculum and key topics such as number, fractions, ratio, percentage, and proportional reasoning.

The document then generates personalised QLA sheet (using a traffic light system) for each student, telling them exactly where their strengths and gaps are. The topics are mapped to the corresponding CENTURY Tech or Hegarty units, to allow students to continue the learning independently.

Mathematics Assessment Feedback

Paper	ACP 3 - Functional Skills Level 2 (Past Paper 2)
Name	0
Teacher	Enter Teacher Name

Questions	Question Title	Score			Nugget
1a	Find the median	2	/	2	ME14.08
1b	Find the mode	1	/	1	MF49.01
2	Formula	3	/	3	ME9.08
3	Fraction of an amount	4	/	4	ME3.07
4	Surface area / Unit conversion	1	/	6	ME13.04, ME10.01
1	Unit Conversion	3	/	3	ME10.03
2a	Coordinates	1	/	1	MF23.02
2b	Plot Coordinates	1	/	1	MF23.26
2c	Angles in a parallelogram	1	/	1	MF28.05
3	Find the mean or median	2	/	4	MF49.03
4a	Percentage	0	/	2	MF11.13
4b	Reverse calculation / Show a check	0	/	1	-
5a	Completing Two Way Tables	3	/	3	ME14.06
5b	Two Way Tables: Probability	1	/	2	ME15.03
6	Mean from Grouped Frequency Table	1	/	3	ME14.11
7a	Volume	2	/	2	MF34.02
7b	Plans and Elevations with Cuboids	0	/	2	MF33.03
8a	3 Part Ratios	3	/	3	MF15.05
8b	Money Problem	2	/	3	MF16.04
9a	Angles of a triangle and straight line	2	/	2	MF28.03
9b	Estimation	2	/	1	MD6.06
10	Speed, Distance, Time	2	/	3	ME10.12
11	Circumference	2	/	5	ME12.03
12	Estimation / Percentage Increase	2	/	6	MD6.06, ME4.03
	Total	41	/	64	

Marks needed to pass	-3	38	Pass mark

Based on my results in this assessment I will focus on the following 3 topics for improvement before my next exam

Topic for Improvement	Nugget

Figure 5

Teachers refer to this document when planning their lessons between assessment checkpoints and students use theirs at the start of every lesson to link the learning to their gaps.

In the first cycle, we hypothesised that if the QLA is used efficiently by teachers and learners, it will increase engagement, motivation as well as outcomes.

Learners recognising the QLA

When the respondents were presented with a screenshot of the Question Level Analysis sheet and asked whether they recognised the document, 90% (192) of the students recognised the document, 4% (8) did not and 7% (14) were unsure.

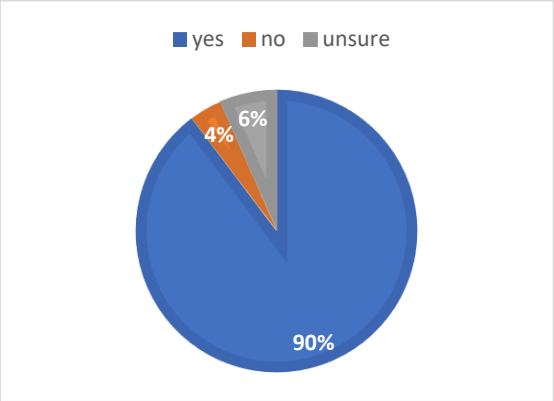


Figure 6

Thirty of the 214 respondents were unable to identify either the name of the document or its use. The rest clearly identified it as Question Level Analysis or Assessment Feedback.

Most of the students were familiar with QLA document, when probed further in lesson, many said that they engaged with the CENTURY Tech or Hegarty Maths units which was reassuring as shown in figure 7. However, usage data from CENTURY Tech and Hegarty show students' engagement, therefore teachers made sure that learning was more targeted after this survey was conducted.

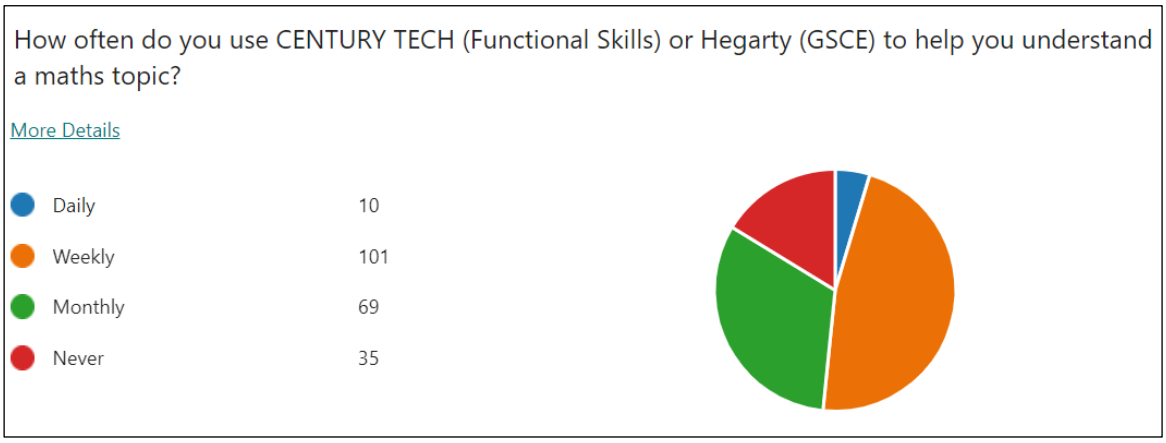


Figure 7

Use of QLA in lesson

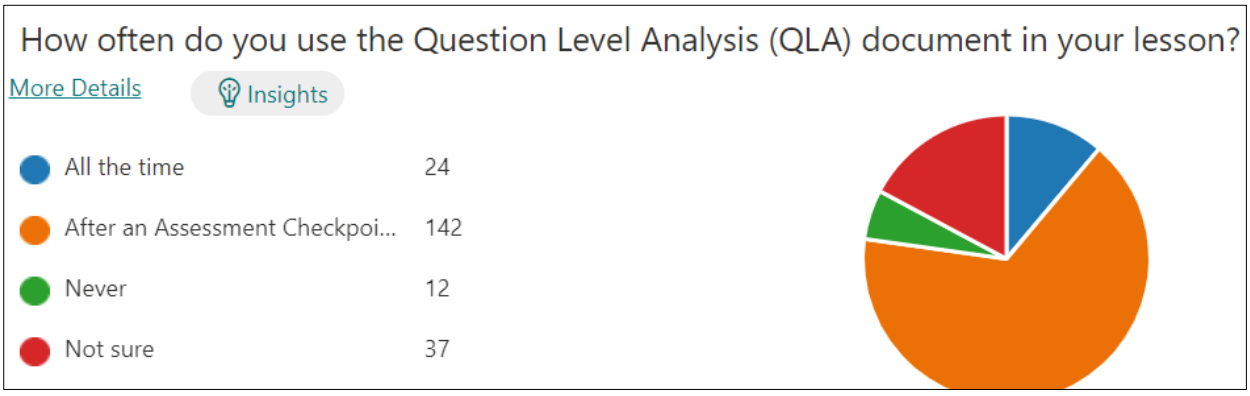


Figure 8

Figure 6 shows that 66% of the students said that they used the QLA document after an assessment checkpoint, which is the main purpose of the document.

This shows that the main utilisation, as seen by students, is providing feedback around their assessment checkpoint.

Disappointingly, only 11.2% of students reported that the QLA is being utilised in all lessons.

17.2% of students were not sure how the document was being used in lessons but this response could also be attributed to students not recognising lessons tools.

However, these results prompted us to review how teachers were perceiving and using this valuable tool.

We designed and delivered a CPD session on the effective use of the QLA in the first cycle of the research and most of the teachers responded well to the training.

Exam practice in lessons

As mentioned previously, the QLA is an effective tool to individualise the teaching, learning and assessment in every lesson and for students to work on their knowledge gaps but most importantly, linked the learning to their examination skills. This was more so important this year as most students had never sat a formal exam due to the COVID pandemic. We placed a lot of importance and focus on teachers linking the learning to exam style questions.

Therefore, it was reassuring to see that 48% were doing so. Again, there was further emphasis placed on exam practice during CPD and this quickly changed. However, as illustrated in figure 9, there was still a big variance in practice.

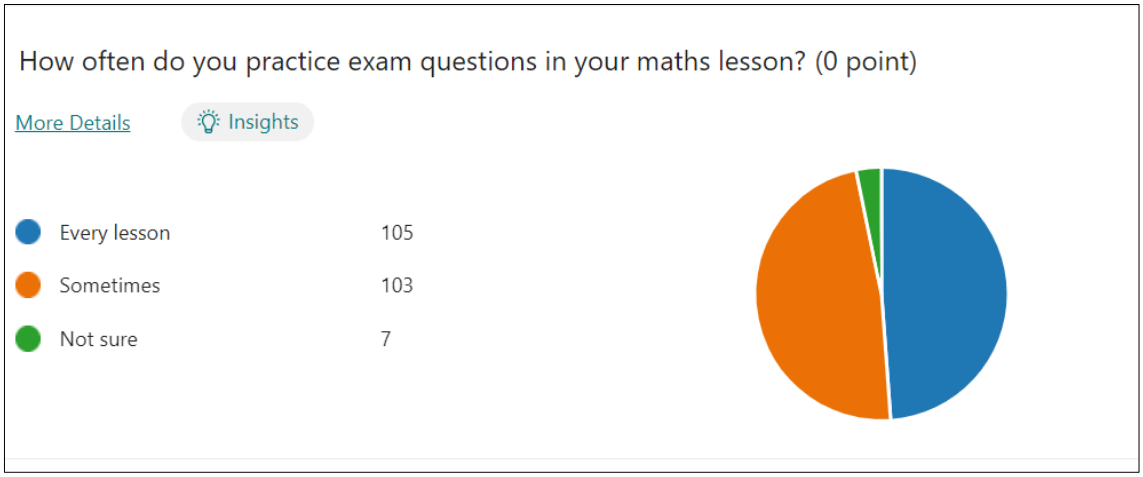


Figure 9

Further breakdown of the data by pathway showed the following:

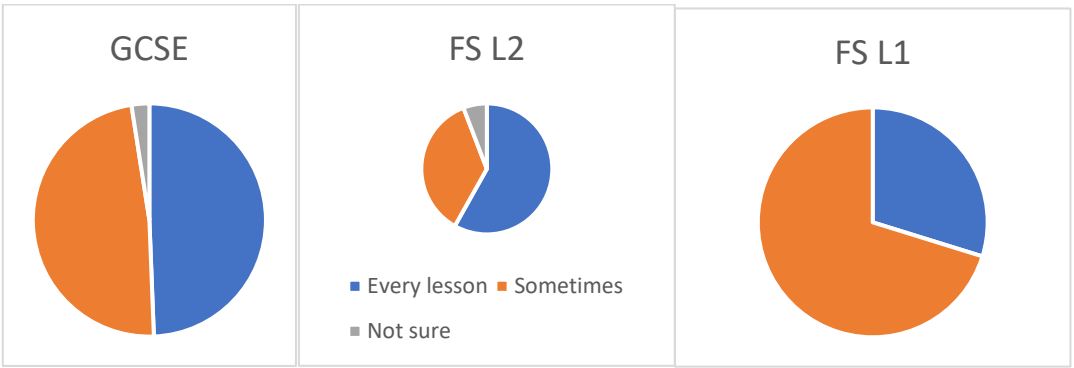


Figure 10

Functional Skills Level 1 Exam Data (Source: Pearson)

This data shows clearly that a responsive approach to teaching works.

Pearson reported that the EKC Group's results were significantly higher than the national average in March 2022.

Figure 11 shows the breakdown in achievement data. The results of the first sitting pass rate is particularly important here as it shows that targeted learning means that learners are going into their exams confident, having worked on their strengths and weaknesses in most of their lessons.

The benefit of practicing exam style questions in every maths lesson is also illustrated in the table below.

This is the data for overall FE 16-18:

Level	Subject	OVERALL	2017/18	2018/19	2019/20	2020/21	2021/22
Level 1	Maths	1st Sitting Pass Rate	38.5%	45.6%	35.6%	23.3%	22.5%
		2nd Sitting Pass Rate	31.1%	32.5%	46.2%	19.7%	16.6%
		Overall Pass Rate	25.2%	29.1%	30.7%	14.8%	13.8%

And this is the same for EKC Group :

Level	Subject	EAST KENT	2017/18	2018/19	2019/20	2020/21	2021/22
Level 1	Maths	1st Sitting Pass Rate	32.8%	53.7%	35.5%	21.2%	45.3%
		2nd Sitting Pass Rate	27.6%	32.2%	50.2%	19.4%	33.3%
		Overall Pass Rate	21.4%	33.6%	32.2%	16.4%	27.9%

Figure 11

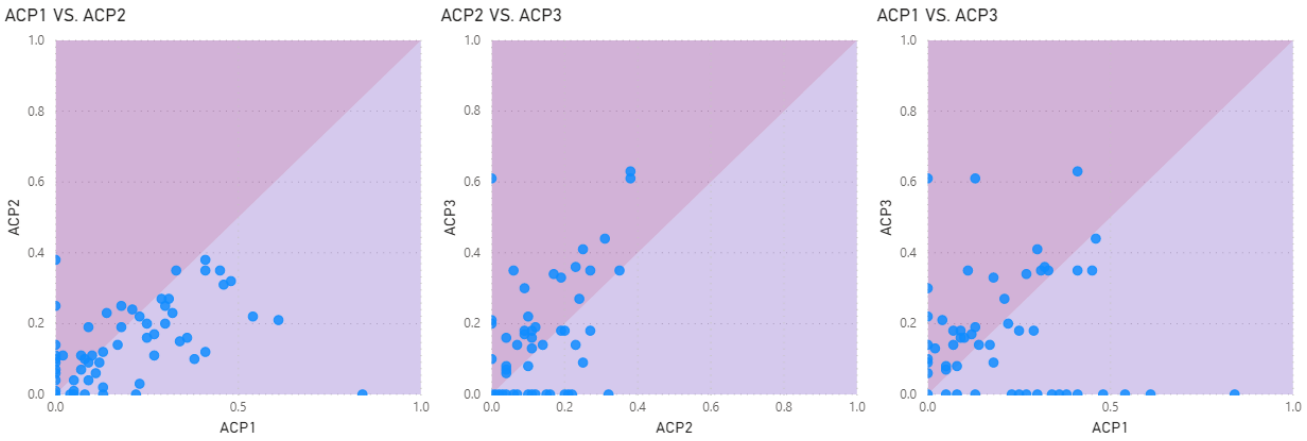
Impact on Assessment Checkpoint versus attendance

For this report, we used data from two of our smaller colleges to compare assessment data and attendance. These were the two colleges where the implementation and embedding of a diagnostic approach was much more prominent and we felt that it would give us a better understanding of the impact of responsive teaching on outcomes.

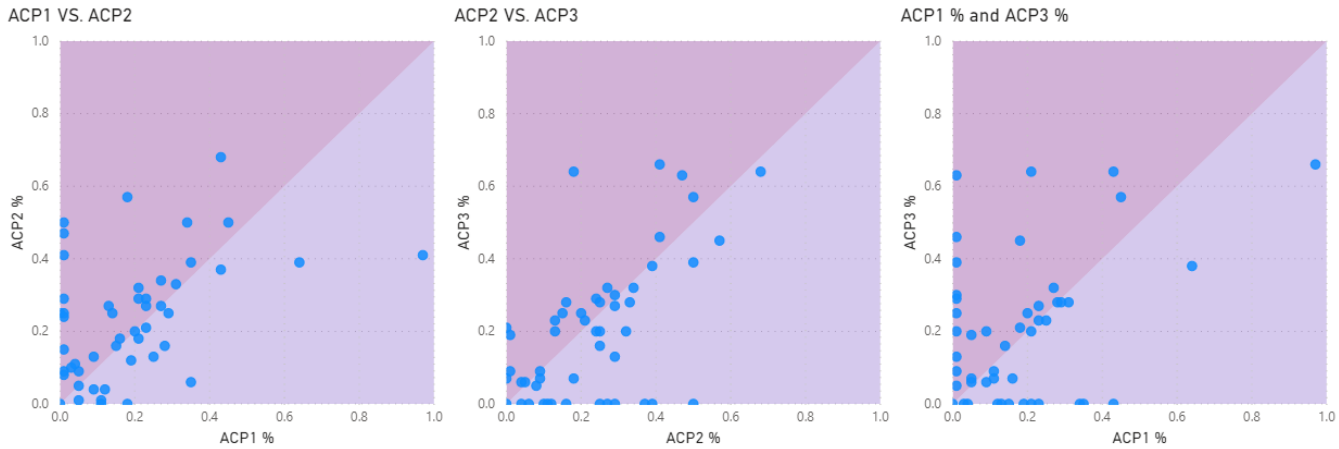
Our larger campuses also had other external variables which may skew the data such as lack of human resources due to COVID related absences, lower attendance and newer members of staff.

LEVEL 1 Functional Skills Maths Assessment Checkpoint Data

Sheppey College



Folkestone College



Analysis:

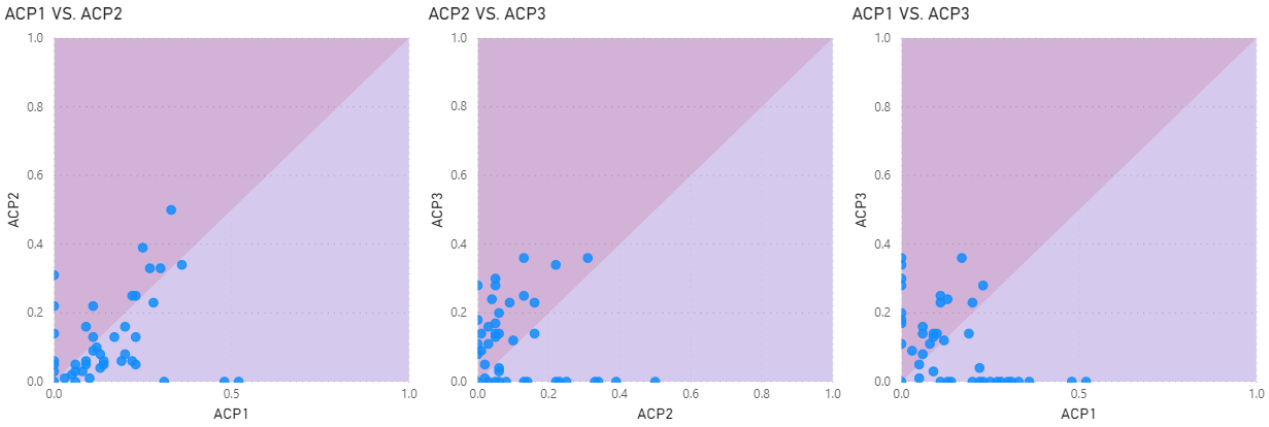
Progress between Assessment checkpoint 1 (ACP1) and Assessment Checkpoint (ACP2) is mixed. Sheppey college performed more favourably in one ACP over the other. Folkestone closely clustered along the centre line with outliers either side. This is much the same for ACP2 & ACP3 except for Sheppey where progress can be seen over the former.

It should be noted that the topics present on each ACP were varied. The extent of the impact targeted learning would have in preparation between papers ACP1 & ACP2 are diminished as their criteria were not relatable. This is a similar case for ACP2 & ACP3.

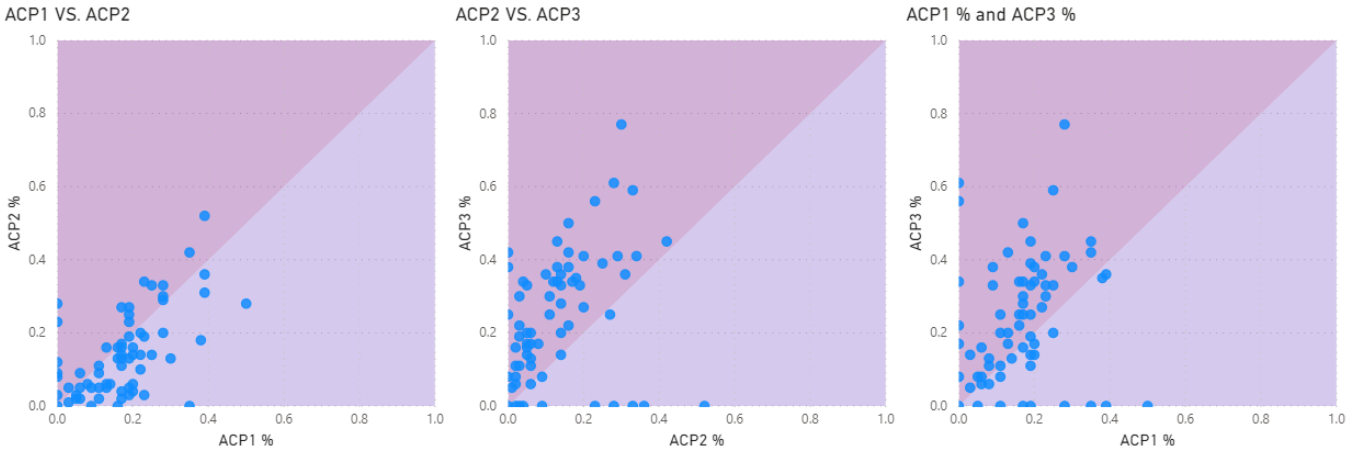
Therefore, comparing ACP1 & ACP3 gives the biggest scope, it considers all the prior targeted learning. Progress measured between these two, for both colleges, make clear that positive progression has been made with learners.

LEVEL 2 Functional Skills Assessment Checkpoint Data

Sheppey College



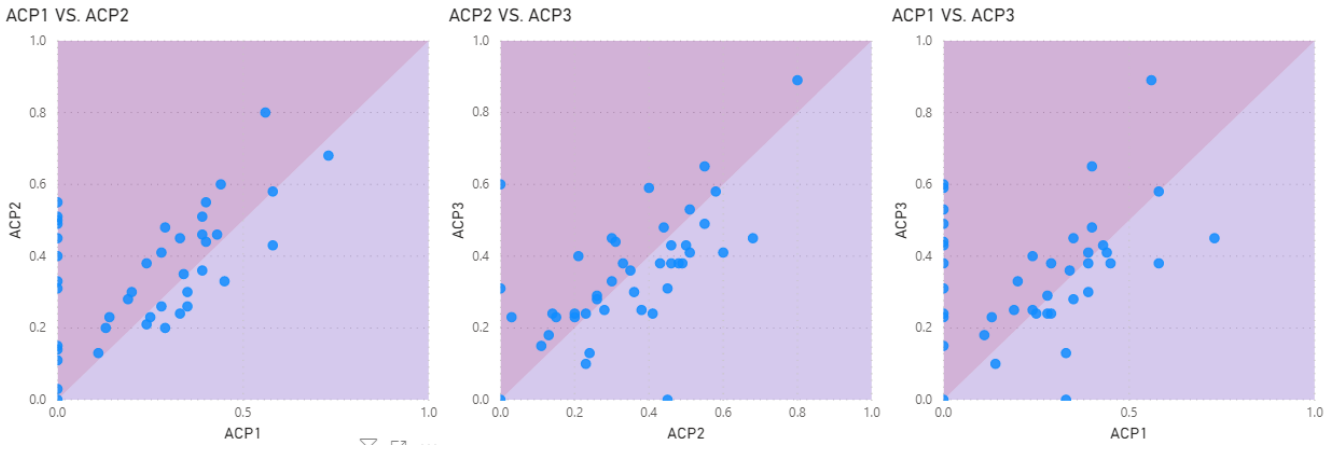
Folkestone College



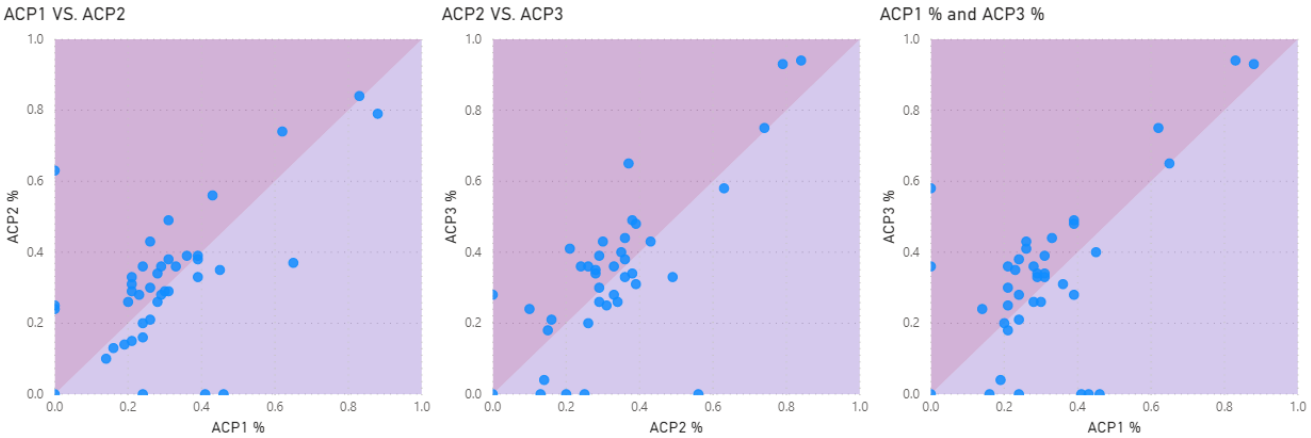
For most learners ACP2 was their weakest assessment out of the three. This is evident from the skew of data on both the axis' of ACP1 & ACP3. Looking at ACP1 & ACP3 progress has been made by most learners.

GCSE – Assessment Checkpoint Data

Sheppey College



Folkestone College

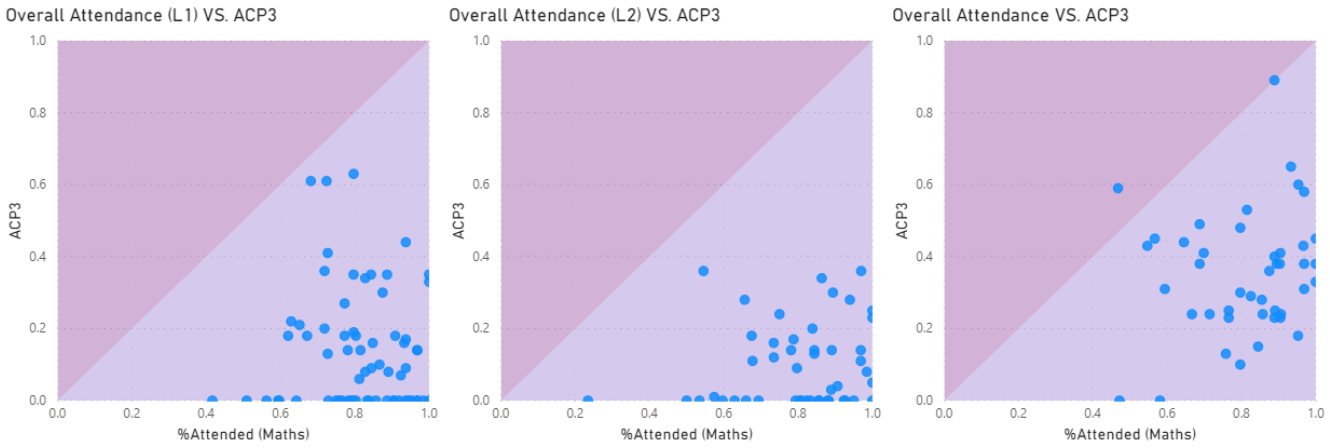


Here we find the most data clustered along the symmetry line. This does not come as a surprise, GCSE assessments unlike Functional Skills are so varied in their criteria from paper to paper, due to the vast array of topics on the curriculum.

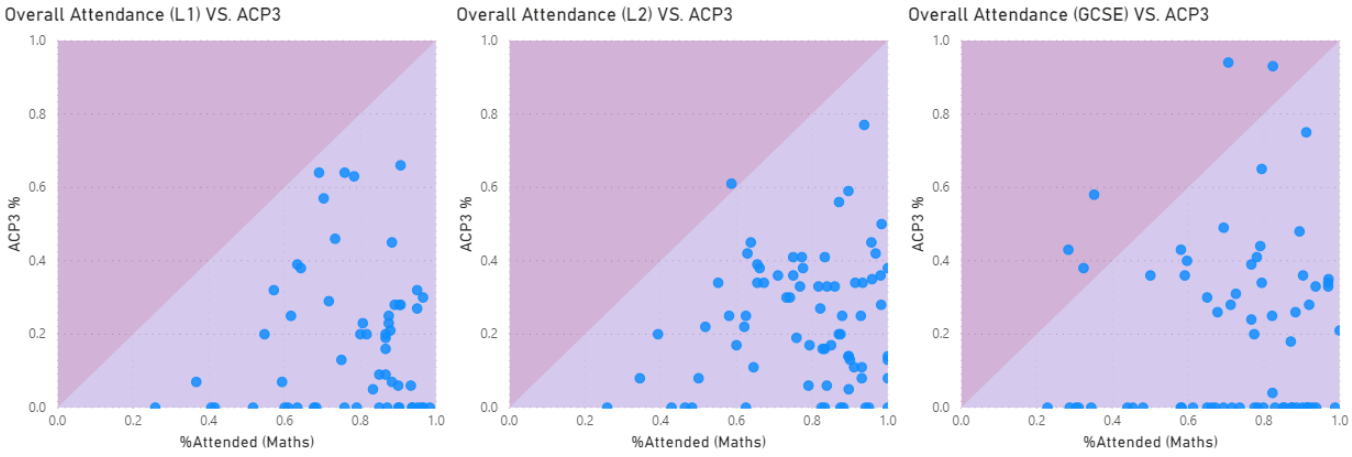
To successfully measure progress on such a vast syllabus, the assessments chosen, need to cover more of the same material. However, this prevents investigation into the wider array of topics, restricting access across the syllabus, which is a luxury seldom afforded given termly time-constraints. Future evidence collected should be based on regular micro-assessments.

IMPACT OF ATTENDANCE

Sheppey College



Folkestone College



There is little to no correlation between attendance and ACP3. We can surmise from this is that attendance alone does not always indicate learning is taking place. Engagement is key to growth; attendance maintains the status quo.

Conclusions and Recommendations

Conclusions

Through our surveys, discussions with students and learning walks, we can summise that a responsive approach to teaching mathematics in further education can be a very successful strategy and have a positive effect on functional skills outcomes if implemented robustly.

Learners in further education come with pre-learnt concepts and misconceptions. They have learnt mathematics for 11 years and their knowledge files are scattered in their long-term memory.

Learning practitioners must act as facilitator to help them re-organise their learnt files into appropriate folders to facilitate retrieval at a later stage, especially when applying this knowledge during exams.

As a teacher aptly puts it: '*It has enabled me to stop teaching things that don't need teaching, however I'm not sure currently it will result in higher achievement.'*

We can also conclude that a responsive approach to teaching can help with:

- Increased collaboration
- Improved communication across our 6 colleges
- Standardised collaborative teaching resources across the Group
- Sharing good practice and peer observation has become standard practice
- Growth mindset across the Group
- Mastering Mastery Maths
- Inclusive practice

Recommendations

We can strongly recommend that practitioners embed a responsive approach to teaching maths in further education rather than following a scheme of work in a linear fashion.

Diagnostic tools such as a Question Level Analysis sheet is very important to map out students' strengths and weaknesses.

We recommend that the QLA is used to plan and deliver weekly lessons and that each lesson can be individualised by learners not by class.

We also recommend the use of Entry and Exit Tickets to further diagnose students' entry and exit points.

However, for this approach to be successful, a robust training system needs to be implemented. Teachers will need coaching on the various pedagogical approaches and if done effectively, outcomes may be positive compared to when delivering a linear scheme of work.

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