CENTRES FOR EXCELLENCE IN MATHS

CAMBRIDGE REGIONAL COLLEGE

Collaborative planning as a tool for teacher professional development

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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

In response to the decline in GCSE maths resit student achievement in recent years, a small group of teachers at Cambridge Regional College (CRC) participated in an action research project. The aim of the project was for teachers to work together on rich tasks that promoted formative assessment strategies. This would provide opportunities to develop a supportive community of teachers who would share ideas and develop their vision of teaching and learning. In turn this could mitigate any feelings of isolation that had arisen through a re-organisation to a de-centralised model of delivery for English and maths. Over a period of six months, six teachers met weekly to plan tasks and reflect on how they were implemented in the classroom.

The development of collective teacher efficacy can describe the impact of the action research. Through planning together, teachers shared different perspectives that helped them better understand the potential of these tasks. The cultivation of a safe environment promoted open and honest conversations about teachers' experiences of trialling new resources in their own classrooms. This led to the empowerment of teachers to take risks and try new formative assessment approaches without fear of judgement by others. In turn, these classroom experiences and opportunities to share different insights have caused teachers to change their perceptions of potential learner engagement and capability.

A whole college approach to improving the quality of the maths teaching provision should be focused on supporting the professional development of staff through the vehicle of teacher learning communities. In acknowledgment of limited downtime, collective teacher efficacy requires leadership teams to ensure that dependable, high trust, collaborative structures are in place and maintained. This involves sympathetic timetabling to enable teachers to participate and invest in improving their practice.

Contents

Contents

Background

Introduction

Following the Wolf Report in 2011, the government legislated that from September 2013, young people who do not achieve a C in maths and English GCSE were required to continue studying those subjects post-16, until they achieved that grade. Porter (2015) explained that the purpose of the policy was to increase the proportion of adults who have functional English and maths skills, and to address skills-based employment gaps.

The introduction of compulsory resits for mathematics for 16 to 18-year-old students without a grade 4 - 9 (C - A* previously) has had a huge impact on Further Education Colleges. As exam entries have increased, the proportion of students achieving a Grade 4 or above has declined (Smith 2017). In his review of post-16 mathematics Professor Adrian Smith discusses how challenges are most likely to be felt in Further Education (FE) colleges, as they take students with lower average grades than school sixth forms or sixth form colleges, and additionally, where there has been the largest increase in numbers studying maths. As Ofsted discuss in their Research review series: mathematics (2021) the post-16 resit program for GCSE mathematics still lags behind the secondary school achievement rates of approximately 60%:

"Almost 180,000 students had to re-sit GCSE mathematics in 2019. Of these, only 22.3% achieved a standard pass (grade 4) or above."

Cambridge Regional College (CRC) is a further and higher education provider, offering vocational courses for school leavers, professional training, qualifications and community courses including English and mathematics. The Centres for Excellence in Maths (CfEM) action research projects, have enabled CRC to explore ways of improving learner motivation, engagement and ultimately achievement. This has involved addressing students' barriers to learning and, as discussed in this report, the use of collaborative planning as a tool for the professional development of teachers.

Research rationale

Our aim at CRC is to enable learners to adopt a positive mindset, build resilience, self-efficacy and to realise their full potential. CRC will help to identify barriers to learning by working with other internal stakeholders, including vocational tutors and learning support staff.

CRC has shown a decline in the higher grades success rate for GCSE Maths over the last few years. Reasons for the deterioration in results are multifaceted. It is recognised both by CRC teachers and in the literature, The Research Base (2014), that a prime contributing factor could be the negative attitude towards learning maths by many resit students. Students' lack of engagement and poor behaviour in class can make teaching a significant challenge. Dalby and Noyes (2018) highlight the need for mathematics teachers to address these issues by using pedagogies that are responsive to students' needs allowing them to build confidence and resilience. Developing such pedagogies requires a sustained programme of professional development.

Another factor that may have contributed to the decline in results was the content and structure of the scheme of work. It was highly prescriptive and attempted to cover most of the curriculum within the space of thirty teaching weeks. Each topic was to be taught separately, without any explicit connections between them. Although this may help develop

procedural fluency, it provides limited support for conceptual understanding and strategic competence.

Furthermore, prior to the establishment of CfEM, maths specific continuing professional development has been very limited, and little of it focused on a more diagnostic, student-centred approach to teaching and learning. Through CfEM funding, however, a small group of teachers were able to collaboratively develop, over a year, a rich set of resources. This professional development was facilitated by an external Education Consultant. Integral to the training was developing a flexible approach to teaching, based on the needs of the students. The feedback from this experience has been extremely positive, and positively impacted teachers' practice.

To help address the deterioration in results, in September 2020, the college moved to a de-centralised structure for delivery of maths and English. Maths teachers worked in allotted vocational teams rather than working in a centralised maths department. Although this move had the potential to help students see the relevance of maths, and so improve their attitude towards it, it did generate, in the teaching staff, a feeling of isolation. Such anxiety was highlighted in the recent MiFEC report (February 2020) as a potential issue when operating a dispersed model of delivery.

Central, therefore, to the action research was an ambition to undertake a sustained programme of professional development. The aim was to foster a culture in which teachers develop supportive relationships in which they share ideas in order to expand their vision of teaching and learning. As such, it would both mitigate feelings of isolation, and provide skills to help teachers tackle students' negative attitudes. The hope was that teachers would collaboratively work on tasks that employed formative assessment strategies and promoted a more connected understanding of maths.

Literature Review

Introduction

A collaborative planning approach should help raise teaching quality across the team and this literature review and subsequent findings will help us understand how to do that effectively. All six members of the Action Research Group (ARG) were engaged in reading, summarising and sharing the literature. This served to bring about a shared understanding of the focus of the action research project.

Key elements in raising student achievement

The ARG chose to explore the literature on content knowledge, teaching resources, teacher beliefs and communities of professional learners as most relevant to improving the quality of teaching and hence raising student achievement in our local context. These four themes are outlined below:

1. **Teacher Beliefs**
   Swan (2006) focuses on the beliefs and practices of GCSE Maths teachers in FE and the impact this has on students, using teacher questionnaires. He explains that beliefs underpin personal thought and behaviour and help people to understand themselves, to understand their environment and to form social groupings around shared values. Beliefs become comfortable, form 'the way things are', and are often resistant to change. Swan highlights that attempts to develop teaching practices must, therefore, attend to beliefs and that changes in them may be the clearest measure of a teacher's professional growth. The perceptions most likely to prevent teachers from implementing student-centred approaches included: a perceived need for syllabus coverage, a lack of suitable resources, the social pressures of the FE culture and a low expectation of the capacity of GCSE students to take advantages of these approaches. In conclusion, his research shows that whilst there are clearly a number of teachers with widely differing beliefs in FE, the predominant practices in GCSE classrooms are almost entirely teacher-centred. As most of the teachers in the sample reported that they were constrained to work in ways they did not believe in, he suggests that professional development activities must pay particular attention to discrepancies between beliefs and practice if they are to become effective.

   Swan (2007) describes how carefully designed tasks can help with changing teacher beliefs and shifting lessons from teacher-centred to student-centred. Swan cites Fullan (1991) who claims that teachers do not change their beliefs through persuasion and therefore PD programmes should encourage them to behave differently so that they may have cause to reflect on and modify their beliefs.

2. **Communities of Professional Learners**
   College maths and English provision was de-centralised from September 2020. We now have a dispersed model of delivery with maths teachers operating from geographically separate vocational areas, across the college. The college supports the need for a professional learning community and therefore enabled a regular, weekly maths team meeting for all to attend. According to Dalby & Noyes (2020), teachers state that they benefit most from informal sharing of ideas in teams and CPD that is directly related to their mathematics classroom practice.

   Darling-Hammond (2017) identify from their extensive research into the features of effective professional development, that high-quality PD creates space for teachers to

share ideas and collaborate in their learning. They also highlight the need for PD to be content focused, to facilitate reflection, solicit feedback and to be of sustained duration. We envisage that our 2-hour weekly maths team meetings will allow teachers opportunities to develop a common understanding of what instructional strategies may or may not be working and for whom. Developing a sense of what is working and why, we intend to adopt and implement professional learning for teachers that is evidence based and designed to address potential obstacles.

Spillane (1999) cited in Golding, 2017 argues necessary conditions for deep teacher change include a social rather than an individual 'enactment' zone, high-quality materials, and rich expert-supported deliberation that is grounded in classroom experience. Korthagen and Vasalos (2009) cited in Golding, 2017 describe how the persistence of teachers in reflective practice brings a host of benefits, including strong feelings of personal security and of self-efficacy in relation to professional actions, better relationships with both colleagues and students and a higher degree of job satisfaction, together with less likelihood of burnout. This is particularly relevant to addressing the feelings of isolation expressed by maths teachers operating in a dispersed model.

Wiliam (2016) argues that in order to change teachers' practice you have to help them change habits - what they do in the classroom day in, day out. He suggests that the most effective way to do this is through small, school-based, teacher learning communities (TLCs) i.e. groups of teachers that meet together regularly to support each other in making changes in their classrooms. He explains that the only people who can be full participants in a TLC are those struggling to make these changes in their classrooms. Other stakeholders think they remember what it was like in the classroom, but they don't. They can provide peripheral support, but they'll never be full participants because they don't know what it's really like. He also highlights that TLCs contradict teacher isolation, re-professionalise teaching by valuing teacher expertise and offer a steady support for struggling teachers.

When a team of individuals share the belief that through their unified efforts, they can overcome challenges and produce intended results, groups are more effective. Bandura (1997) called this "collective efficacy". Donohoo (2018) refers to John Hattie (2016) positioning collective efficacy at the top of the list of factors that influence student achievement. His Visible Learning research, based on a synthesis of more than 1,500 meta-analyses, found that collective teacher efficacy is greater than three times more powerful and predictive of student achievement than socioeconomic status. Donohoo (2018) explains that the link between teachers' actions and student outcomes must be made explicit, so that teachers understand that the factors behind student progress are within their collective sphere of influence. Collective teacher efficacy requires leaders to ensure that dependable, high trust, collaborative structures are in place, so that teachers learn from and with one another and build common understandings.

3. Content Knowledge with a focus on formative assessment

Pedagogical content knowledge (PCK) is acknowledged in the research as a key aspect of good teaching. Shulman (1986), an eminent academic in this field of research, provides a useful description of PCK as the most useful ways of representing and formulating a subject that make it comprehensible to others. PCK also includes an understanding of what makes the learning of specific topics easy or difficult for students. To be effective, teachers need to be familiar with common misconceptions and methods

for recognising and addressing them. It is important to note that GCSE resit students do not arrive as ‘blank slates’.

Ball (2008) asks what do teachers need to know and be able to do in order to teach effectively? Acknowledging the immense importance of content knowledge to teaching and its improvement, she introduces two subdomains of pedagogical content knowledge (knowledge of content and students and knowledge of content and teaching) and an important subdomain of “pure” content knowledge unique to the work of teaching: specialized content knowledge. Knowledge of content and students includes understanding common misconceptions held by students and how to address them using multiple representations; and knowledge of content and teaching would include how to sequence particular topics in a scheme of work in order to facilitate teaching for understanding. Specialized content knowledge may include the teacher being able to perform mathematical error analysis on the spot and respond to learners quickly and effectively.

Rowland and Zazkis (2013) connect content knowledge with formative assessment. They emphasise that, in addition to delivering a predetermined curriculum, teaching involves dealing with unpredictable, contingent events in the classroom including attending to students’ questions, anticipating some difficulties and dealing with unexpected ones, taking advantage of opportunities and making connections. To do this effectively, the teacher must solve a pedagogical problem directed at facilitating the students’ accessing and engaging with the solution of a mathematical problem. A teacher’s responses to problematic contingent moments that arise in teaching mathematics, are fundamentally dependent on their mathematical knowledge which prompts and guides them on what to do next. Wiliam (2016), justifying pedagogies of contingency, explains that we should use assessment to influence learning and that the teaching should be contingent on what students have learnt. Evidence must be collected about where students are at while we are teaching, so that we can make adjustments to our teaching to better meet our students’ learning needs. He reports that teacher professional development focused on assessment for learning (AfL) is the most cost-effective way of raising student achievement and that the research shows that short cycle formative assessment has the biggest impact on student learning. AfL becomes formative assessment only when the evidence of student learning is actually used to adapt the teaching work to meet student needs. Wiliam argues that if this information is not used to make a difference to your teaching within a day or two then it’s unlikely to make a difference to student achievement.

4. Teaching Resources

Barton (2018) explains that multiple-choice diagnostic questions are designed to help identify and understand student’s mistakes and misconceptions in an efficient and accurate manner. The use of diagnostic questions also enables the teacher to study the wrong answers in advance and plan for those errors to ensure they have the explanations, resources and strategies ready to help. Thinking ahead of the lesson and being prepared for common misconceptions will make the teacher much more effective during the lesson. It is important to note that many formative assessment strategies, including diagnostic questions, require students to be public about their answers, displaying their thoughts in front of their teacher and peers in the moment. For this to be successful the teacher needs to create a classroom culture that helps students overcome a fear of making mistakes and the consequences of those mistakes: a particular challenge with a GCSE resit class. Lemov (2015) highlights the importance of

developing a ‘Culture of Error” in the classroom where it is safe to struggle and fail and where mistakes are embraced as learning opportunities. It also requires full participation of students where “opting-out”, because they don’t want to think, is not an option.

Swan (2008) explains the research-based principles that he uses to design learning experiences to foster conceptual understanding. He describes one of the task types “Interpreting multiple representations” that focuses on an aspect of mathematics that is often taught, with limited success, in a mechanistic manner. It supports teachers in moving away from a ‘transmission’ orientation to a more ‘collaborative’ orientation where learners are challenged and arrive at understanding through discussion and see mathematics as an interconnected body of ideas and reasoning processes. Throughout the task the teacher is required to prompt students to make connections between the various representations, make misunderstandings explicit and encourage reasoning rather than ‘answer getting’. This rich, collaborative task involves the development of the students’ mathematical language as they are required to articulate their understanding publicly. The design of this task was taken from a nationally distributed resource for teachers DfES. (2005) and was developed as part of a research project with low attaining 16- to 19-year-old students in Further Education Colleges.

Summary

Swan (2006) and (2007) describes the impact of teacher beliefs and a process to change them. Fullan (1991) acknowledges that the beliefs of teachers do not change through persuasion alone. This suggests that in order to change these beliefs and to give staff the courage to try new teaching approaches, new resources and a support network would be required. Wiliam (2016) advocated the setting up of a TLC to facilitate this process and specifies that the personnel involved should be exclusively teachers delivering and assessing their own practice.

The ARG with expert guidance will investigate current teacher beliefs and explore the models suggested in this literature review with a view to effect a positive change on the beliefs and practice of maths teachers at Cambridge Regional College.

Methods

The research aim pursues not just the extent to which the intervention was successful but an understanding of how and why teachers' beliefs and priorities guided their behaviour during the intervention. The objective was to describe the project in a believable, realistic way that accurately reflected the complexities of carrying out the intervention. It is hoped that such description can support the refinement of the intervention and help other teachers to implement it more effectively in their own colleges. How this approach was realised, is the focus of this section. The project process is outlined below (Figure 1).

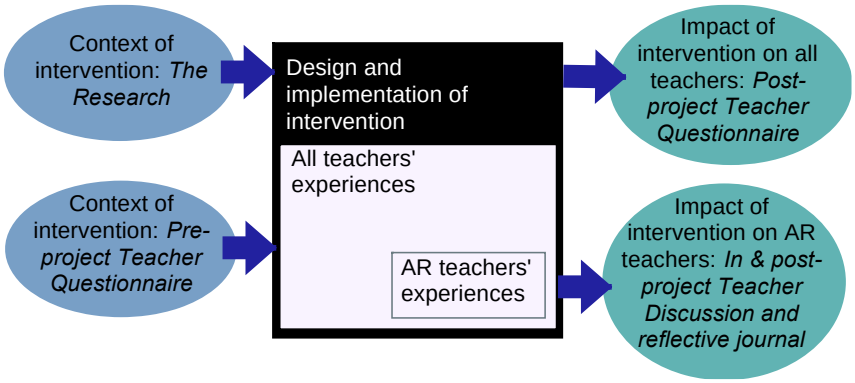

Figure 1

The Intervention

Central to the intervention was ensuring that teachers were regularly working together on tasks. This included refining existing tasks and reviewing how they were implemented in the classroom. The ambition was that the whole maths team would meet on a weekly basis. However, for pragmatic reasons, early in the project, this was scaled back to the six members of the Action Research Group (ARG) meeting online for one or two hours each week throughout the six-month project. Teachers then, on occasions, shared their ideas with the larger CRC maths community in an organised professional development session. This was undertaken by a pair of AR teachers formally presenting a task and then leading the discussion on its learning potential.

Integral to the project was a Scheme of Work (SoW) developed by the ARG. The new SoW shifted away from specifying what needs to be done on a week by week, 'conveyor-belt', basis, to a larger grained approach with groups of topics identified to be taught over several weeks.

It is important to note the disruption caused by Covid-19. Lockdowns and remote lessons placed additional demands on teachers and students leading to online fatigue and specifically, altering the dynamics of interactions in the class. It also limited the scope and potential impact of the tasks selected to promote dialogic learning.

The data collection and analysis

Both the existing research and a pre-project questionnaire guided the design and implementation of the project. Figure 1 shows that the impact of the intervention will be measured and assessed using thematic analysis of key statements collected from: teacher questionnaires, reflective journals and teacher discussions.

Details of the measuring instruments are provided in Figure 2. Integral to the capturing of all the data was an intention that the tools would also support teacher development. The

Journal, for example, prompted teachers to reflect on their practice, as well as capturing useful information. See Appendix A - D for examples of the instruments.

Data source	Research Purpose	Type of Data	Amount of data collected
Pre-project questionnaire	Provide a context and guide the intervention. The focus was on teacher beliefs, enthusiasms, priorities and challenges. Much of this was based on the work of Malcolm Swan (2006).	Qualitative & quantitative	17 teachers, including 5 AR teachers
Reflective Journal	Capture teachers' ongoing perspective of the intervention.	Qualitative	6 AR teachers
Video of discussion of a task	Exemplify AR teachers' discussion of a task.	Qualitative	6 AR teachers
Post-project video of discussion on learning	Capture teachers' perspective on what they have learned from the intervention.	Qualitative	6 AR teachers
Post-project questionnaire	Capture teachers' perspective on the impact of the intervention	Qualitative & quantitative	17 teachers, including 5 AR teachers

Figure 2

To help understand both what happened when the intervention was implemented, and why events occurred, the qualitative data collected was described using a thematic analysis. Thematic analysis is a method of systematically identifying and interpreting patterns in the data (Clarke and Braun, 2014). Using a grounded approach, the data was interrogated through the generation of codes. These carefully designed codes formed the building blocks for the emergent themes (see Appendix E for an example). At each stage of the analysis unconscious bias was minimised through a carefully controlled checking procedure. This rigorous analysis provided a robust framework to both organise and report on the data.

Design Iteration

An iterative process of refinement of both the design of the intervention and the measuring instruments was evidenced throughout the intervention. For example, as a result of teacher discussions, AR teachers decided to reduce the number of diagnostic questions used in any one lesson and move to a focus on shorter tasks. Also, as previously mentioned, the project was scaled back to focus primarily on the AR group.

Results

Findings from the various data sources were combined to provide a rich description of the intervention and its impact. These can be classified using the following overarching themes: collaborative teaching communities, teaching approaches and resources. For the sake of coherence, the themes are discussed separately, however it is recognised they are overlapping and interdependent.

1. Collaborative Teaching Communities

Collaborative teaching communities develop when teachers meet regularly over a sustained period to discuss the issues of teaching and learning that are important to them. Through a process of collaboratively planning of innovative resources, implementing them in the classroom, and then reflecting on the learning, teachers have the opportunity to share ideas, develop their practice and provide mutual support. At CRC such a community emerged. It consisted of six AR teachers who were in turn part of the wider community of the whole maths team. How these communities developed within the project are outlined below.

1.1 Teacher Perspectives: Pre-project

The thematic analysis of responses to the initial teacher questionnaire provided a detailed picture of teachers' beliefs, priorities, enthusiasms and challenges. Below we report on the key factors that emerged.

- **Collective efficacy**
  The majority of teachers believed that supporting and being supported by maths colleagues was key to maintaining their enthusiasm for teaching. This, however, did not include Continuing Professional Development (CPD). Teachers did not recognise CPD as directly supportive of their maths teaching.
- **Dispersed model of teaching**
  The data revealed that, following a restructure of the maths department from a centralised to a dispersed model in September 2020, teachers felt isolated and unsupported. A quote that represented the overall feedback stated:

  "Lack of support - our workload is incredible, and since we've been separated... I have found collaboration and cohesiveness as a maths team at an all-time low..."

1.2 Teacher Perspectives: In-project

The ARG Reflective Journal revealed teachers' perspectives on the intervention as it unfolded. A discerning honesty permeated through many of the comments in the journals. These, for example, captured the extent teachers were prepared to take risks when trying out a task that was new to them. The focus of teachers' concerns was the fear of learners' lack of engagement. However, teachers appeared to take courage from the knowledge that others were also undertaking such risks and others experienced failures as well as successes. These 'car crashes' were discussed both within the meetings and in the journals.

Such honest reflection was made possible through the supportive culture developed within the ARG. As one teacher reported during the meetings" *"… no fear of judgement was essential here."* This safe environment helped develop a collective efficacy and was reinforced by working together on presentations for the whole maths department:

"Planning the presentation together was a useful experience and I felt very supported by my colleague."

There was limited evidence of this collective efficacy permeating the wider maths team meetings.

1.3 Teacher Perspectives: Post-project

Most teachers in the wider maths team saw the benefits of working together. As one teacher reflected:

"It seems to be more comprehensive and cohesive than in previous years - and a stronger sense of "why" we are doing it and how it will help us and our learners."

The smaller group of AR teachers were extremely positive about collaboration. They not only enjoyed it, but recognised it helped them develop their teaching practice. The core benefits are listed below:

- **Sharing ideas**
  Teachers expressed the advantages of sharing ideas, and together, refining tasks. It emerged that all the AR teachers had a slightly different perspective on teaching and learning. One for example, emphasised the use of visual representations, another often focused on learner talk, and a third was always keen to ensure learner confidence underlined teaching strategies. Teachers recognised that learning from each other allowed them to reflect and extend their own practice. This was encapsulated in the following comment:

  "…sharing of that experience, relying on others who've done it before... That's the true essence of collaboration ... I can say to [teacher 1] 'What did you do with this?' … I love listening to her practical ideas. I can't get enough of that. Then I listen to what [teacher 2] said and I will pick [teacher 3's] brain, and he will ask uncomfortable questions and I have to think ... What did I do? Why did I do it? What's the purpose of it?"
- **Collective Efficacy**
  Teachers reiterated that working together had encouraged them to take the risk of trying something new in the classroom:

  'It has taken away the fear of doing something different'

  Many, moreover, appeared to be prepared to experience some degree of initial failure when attempting a new strategy.

2. Teaching approaches

Teaching approaches are driven by teachers' beliefs and pedagogical content knowledge. How they changed as the project progressed are reported below:

2.1 Teacher Perspectives: Pre-project

In the initial questionnaire, teachers detailed their beliefs on teaching and learning, and their teaching practice. Below are the key findings:

- **A teacher-centred, procedural approach**
  A teacher-centred approach was dominant amongst teachers. A variety of views emerged as to whether a teacher-centred approach should be taught in a procedural or connectionist way. More teachers opting for the former. Treating the learning of maths topics as separate, unconnected 'pools' of knowledge, appeared to be driven by the belief that a connectionist approach would promote cognitive overload for resit

students. Some teachers, for example, commented that their students had difficulty working independently for long periods of time. This did not, however, mean teachers thought a teacher-centred approach was the best approach. Indeed, several teachers expressed a desire to be more student-centred but felt that the reality of working with disengaged learners meant that they were unable to achieve this.

- **Engaging Students: Helping 'failing' students**
  Teachers prioritised, and gained much satisfaction from, helping students who have previously struggled with maths. Many teachers valued creating a relaxed, supportive atmosphere in their classes. This was driven by a sense of students' negative experiences of maths in schools, and a desire that they would have a different, more positive experience in a CRC classroom. One teacher, for example, stated:

  "I think a relaxed, informal style of teaching approach works best with some of the groups that I have taught, as usually they come from schools where they were excluded, shouted at etc."

  Many others also expressed a desire to build personal relationships with their learners. Most teachers, however, also observed that their biggest challenge to their teaching was learner poor behaviour in class. They generally commented that this was linked to their lack of confidence and motivation.

- **Formative assessment: Students' individual needs**
  It was widely asserted that meeting students' individual needs, although an ambition, was difficult to achieve. A key barrier, teachers reported, was that they were routinely faced with a classroom of students with a wide range of prior knowledge.

- **Time**
  Many teachers felt they did not have enough time to plan their lessons properly.

2.2 Teacher Perspectives: In-project

Evidence from teacher discussions and their journals revealed a reflective practice which included a new perspective on learner expectations. These are outlined below

- **Student engagement**

  The journals revealed that maintaining student engagement was a priority for AR teachers. They recognised this could be achieved in multiple ways. For example, starting an informal discussion could help learners feel more relaxed and responsive, or beginning a lesson with a concept that learners were familiar with:

  "[It] allows them to participate in conversations that they might not usually contribute to. I can see how it would bring algebra to a level all can engage with."

  Another ARG teacher mentioned how, although students may be slow to engage, it is worth persisting:

  "At the beginning students were reluctant to say anything. They said it is too difficult and too complicated to find the fractions for all the shapes. I tried to motivate them and I said, 'Try to find just one fraction; the one that you find easier'. Then I got one correct answer from a student. Next step was to discuss with students, and I asked them questions like 'Why was that rectangle easier that the others?' 'Is it easier to find a small rectangle or a large one?' 'Is it easier to find a triangle or a rectangle?'

'How many times is bigger the rectangle than the triangle?'. After these questions some students were able to see relationships between the sizes of the different shapes. At the end (after 20 minutes) we were able to work out all the fractions."

- **Formative Assessment**
  There was much mention of teachers developing formative assessment strategies, including the need to find out what learners know, rather than assuming they are a 'blank slate'. Key to this strategy was providing enough time for learners to answer a question. For example:

  "I will wait more time for students to express their ideas and then I will try to develop them."

  and

  "Working in a slow pace gives students the time to digest the new information and feel confident to use a new method.""

2.3 Teacher Perspectives: Post-project

The ARG post-project discussion revealed that teachers perceived they had developed many new teaching strategies over the year. Teachers affirmed that their pedagogical content knowledge and knowledge of teaching had improved. This is exemplified in the quote:

"This year's training made me reflect on my method of teaching maths. I hope to see more training like this in the future."

Key teaching strategies are listed below.

- **Formative Assessment: Finding out what students know**
  AR teachers embraced a more student-centred approach to teaching. For example, one teacher specified that they now restrained from telling learners they were right or wrong immediately after the learner had provided an answer. Doing so, they realised, could close down the learning. Instead, they focused on the learner's method.

  Another teacher added that the process of shifting to a more student-centred approach was disconcerting as it made her question her whole approach to teaching.

- **Formative Assessment: Pace of learning**
  All AR teachers recognised the decision to move on to another topic should not be based on pressures to cover the curriculum. Rather, it should be based on an understanding of student thinking. Several factors appeared to encourage teachers to embrace this teaching strategy. The less structured new SoW gave teachers permission to use their professional judgement to decide for themselves when to move on to a new topic, when to spend time strengthening fragile understanding, and when to review a topic. As such teachers could better address the individual needs of students. Knowing that other AR teachers were doing the same, gave them the confidence to undertake this strategy:

  "I would have more guts now to actually stick with what I think would be right rather than going from week to week. If, in my opinion, they are not ready to move on, we are not moving on"

AR teachers acknowledge that this flexible approach may not be adopted or appreciated by all teachers. Less experienced teachers may find a more prescriptive approach attractive. It gave them the security of knowing you were getting through the work at the expected pace:

"*When I started the safety net [of a week-by-week SoW] gave me the opportunity to say great, I know exactly what I'm doing and what will happen for every single learner in every single lesson"*

- **Formative assessment: Questioning and explaining**
  Many AR teachers expressed a desire to change to more open ways of questioning learners. For example, one teacher asserted that they now try:

  "to ask [[questions] without leading them and giving them chance to actually say what they know."

  Some teachers did acknowledge, however, that their approach was at times, 'one size fits all'. This approach was deemed necessary, not because teachers regarded it as a good option, but because they were often pushed for time to plan effectively. There was also an acknowledgement that occasionally, when students were struggling, they lacked alternative approaches to help them overcome barriers - they simply drew on their own experience of being taught that particular subject.

- **Content knowledge: Prioritising topics**
  The teachers commented that they now had the experience to differentiate between, for example, the importance of percentages, compared to factorisation and can, accordingly, spend more time on the former. However, less experienced teachers may not have developed such knowledge.
  "If I was teaching first time, and had no experience… If I had no chance to talk with other math teachers. I wouldn't be sure that percentages are more important than factorizing."

- **Engaging Students: Classroom Culture**
  AR teachers emphasised that the introduction of new strategies required a classroom culture that felt safe for learners. Although all acknowledge that learning is often accompanied with a certain amount of struggle, teachers also were keen to stress that these students had experienced many years of making mistakes. The mantra 'learn from your mistakes' may ring hollow for many.

3. Resources

Here the term resources refers to maths tasks, teacher guidance, and assessments.

3.1 Teacher Perspectives: Pre-project

Responses to the initial teacher questionnaire revealed that in the past there had been minimal organised collaboration on the use of new resources. It was often just by chance that teachers found out about a good resource. For example, when teachers met at breaks, they would exchange tasks. This, generally, was not accompanied by a discussion on the potential learning benefits of the task. This year, under the dispersed structure, there was even less opportunity to share resources:

"... this year has proven to be so much more difficult as sharing resources isn't as easy as turning to your desk buddy and asking for a PowerPoint or a resource."

3.2 Teacher Perspectives: In-project

Entries in the reflective journals referred extensively to the tasks, including:

- **Potential of tasks**

  The journals revealed how discussing existing tasks with other teachers can extend their potential:

  "We were discussing a resource I've used in the past ... I was happy to propose it as a good resource ... It turned out it has a huge potential to be a good resource but when we analysed it on a deeper level, I've realised how little of its potential I've used."

  Many of the diary entries recognised how the activities had the flexibility to work at "different levels".

- **Learner Engagement**

  Many ARG entries commented that the tasks in the project were different from what they were accustomed to, and teachers were apprehensive about using them. Their key concern was lack of learner engagement. However, teachers were often surprised and impressed by learner engagement:

  "It was a different activity than I was used to. I felt nervous because I did not know how students would react. I felt good when I realised that students actually liked the activity and participated. I even noticed that students who are reluctant to speak were asking questions."

  "I was impressed to see that all the learners bought in to this method and simply having a table to structure their thoughts seemed to give them permission to test ideas."

  The concern of not sustaining learner engagement meant some teachers cut short the task. As one teacher reflected, possibly a "missed opportunity". Another teacher reflected on the relationship between engagement and task:

  "I have learnt that my students' reluctance to participate at various times is very likely the result of the task I am presenting them with - not simply a fixed trait that they possess!"

  Several teachers mentioned the benefits of using a visual representation, including a ratio table, as a tool to facilitate engagement and learning:

  "This is a very difficult group to engage, they are usually very unresponsive and not willing to try anything but would rather be shown something first. With the ratio table they were all offering suggestions and ideas, working towards a common goal."

3.3 Teacher Perspectives: Post-project

The AR teachers collaboratively reviewed, in-depth, the resources and all teachers expressed, in the post-project questionnaire, their views on the resources. Here we divide these perspectives into assessments and tasks categories.

- **Tasks**

Feedback from the post-project questionnaire revealed that most teachers were appreciative of the padlet resources (see Appendix F-H). Teachers praised the variety and quality of the tasks. Furthermore, they appeared to alleviate the pressure of lesson preparation and helped to generate ideas to facilitate a move towards a more student-centred approach to teaching:

"I have used many of the resources and have found them very useful. It made me think about different ways of teaching the topic and to look at my existing resources with fresh eyes."

There was also a sense that sharing the resources helped encourage confidence in the resources and reduce the feeling of isolation brought about by both the online working and the dispersed structure. Others mentioned how discussing a task helped them see its potential for learning in ways they would not have done if reviewing the task in isolation. Some teachers mentioned it improved their confidence as teachers.

AR teachers made a wide variety of comments about the characteristics of a good task. Core was how visual representations, such as the bar model, could facilitate learning. Another key element of a task was its length. Teachers preferred shorter tasks that did not take up the whole lesson. This, they specified, was less risky - if they did not work out as planned, teachers could quickly move on to another activity.

A third characteristic to emerge was focused on formative assessment needs. These consisted of:

- **Pre-designed differentiation within tasks**
  AR teachers recognised the value of attending to the learning needs of individual students. This, they commented, can be achieved through carefully designed activities that facilitate the engagement of a wide range of learners, rather than having a different activity for each learner. Many of the activities on the padlet met these criteria.

  "[they can work] at different levels…you can have differentiation without having to use lots of resources...that makes my life easier"

  It was also mentioned how the flexibility of the task can make life more interesting for the teacher:

  "You can go to all different places with it, depending on where your students are at, and that's exciting when you present the same resource and get a different response from what group you've got. It makes the teacher's job much more interesting, and you can share that experience with your other groups."

- **Diagnostic questions**
  AR teachers were positive about the use of diagnostic questions to help them understand where students are at, and where they needed to go next. The questions can also convince students that their teacher is there to support them, was affirmed by one teacher's comment:

  "very quickly on in the year the students are going to make their mind up whether I am going to be of any use to them or not. And those diagnostic questions are a way of me laser focusing in on what they don't understand, and if I can communicate that

to them in a positive way and involve them in that discussion, I've got their buy-in - that they've got a maths teacher who knows where they need help. And I think that is a massive step forward to building a relationship of trust that they haven't had, maybe, in the previous 11 years."

Teachers, however, also expressed a need to not overload learners with too many diagnostic questions at the same time as students will start to 'randomly guess'.

- **Assessments**
  Most AR teachers felt that there were too many assessments and the content of them was not fit for purpose. They asserted that the reason for the assessments were mainly driven by data gathering priorities rather than student learning. Indeed, teachers thought these priorities tended to impact negatively on learning. One teacher, for example, mentioned that the assessments took too much time and promoted disengagement, particularly when students were assessed on topics that they had not been taught. Some AR teachers were also concerned that teachers knowing the content of the assessment in advance drove coverage rather than understanding.

- **Sequencing topics**
  There were mixed opinions on the sequence of topics. Several teachers agreed that basic number work should be a priority, with it appearing in small doses throughout the terms. However, another teacher conjectured that students, with 12 years of schooling behind them, still lacking basic knowledge of multiplication facts were not likely to develop such skills over one year. AR teachers did not agree on a set sequence, but speculated that the previous, week-by-week scheme of work was not the best solution. Many agreed that from a pragmatic perspective the first few weeks were usually a write-off as timetables, staffing and rooming took up most of the time.

- **Teacher Guides/Plans**
  AR teachers recognised the importance of written teacher guidance. Without such guidance it can be difficult to fully understand the purpose of the tasks. However, it was also acknowledged that just because there is guidance doesn't mean teachers would read it. Discussing the tasks together, AR teachers asserted, is by far the best way to clarify the key learning goals and how to achieve them. This was confirmed in the post-project assessment:

  "I would like to discuss as a team some of the interesting resources on the padlet, particularly how people use these resources and what preparation they have to do in advance in order to use them efficiently."

Discussion

In order to evaluate the successes of the project, within this section, the results are interpreted and located in the literature. In alignment with the Results section, the interpretation revolves around three core aspects of the project. These are outlined below:

Collaborative Teaching Communities

The need for the development of teacher communities within a dispersed model is highlighted in the MiFEC report (February 2020) and was corroborated through the responses to the initial teacher questionnaire. This desire to work together was expressed by many teachers, and the initial aim was to include all teachers in all aspects of the project. Practical reasons, however, required these ambitions to be scaled back early in the project though 17 teachers were surveyed twice and 6 met weekly and kept reflective journals.

The focus of most of the intervention on the work of the ARG is consistent with the research of Wiliam (2016) on changing teachers' practice. He explains that the only people who can be full participants in a teacher learning community (TLC) are those struggling to make the changes in their classrooms. The ARG was a subset of the maths teaching team and equivalent to Wiliam's description of a TLC. Full maths team meetings also included external stakeholders. The makeup of the two different groups may go some way to explain why the strong collective efficacy, developed by the ARG, was not mirrored in the wider team. Project discussions taking place within the full maths team meetings were less productive. The presence of non-teaching stakeholders and the wider maths teaching team resulted in some tension as ARG members had already taken risks to deliver in an experimental teaching style. Therefore, further exposure to risk of judgement, criticism or lack of support, when engaging in discussion about the project, limited open and honest conversations and the progress of the project in this forum.

These findings corroborate Donohoo's (2018) study. He found that collective teacher efficacy requires a collaborative environment of high trust, in which teachers can build common understandings. The strong progress of the ARG was due to its intrinsic personnel, who were open to exploring new teaching approaches. This reflects the make-up of a TLC as specified by Wiliam (2016). It should be exclusively populated with teaching staff who are invested in developing their practice, united by the same passion, goals and risks.

The benefits cultivated within the ARG included heightened confidence in teaching, improved relationships with colleagues and students and a higher degree of job satisfaction. These findings echo the research undertaken by Korthagen and Vasalos (2009).

Further evidence to underline the positive experience of the ARG is that members of the group are keen to be involved in the research project in the coming year, which will be led by one of them.

Teaching Approaches

Another benefit to emerge from the development of collective efficacy was the preparedness to try out innovative approaches in the classroom. All ARG teachers perceived this as a risky endeavour but were encouraged to do so in the knowledge that others were undertaking similar risks. Further encouragement was found in the honesty of how teachers reflected on their classroom experiences. From the beginning of the project, teachers were prepared to voice the difficulties they had faced when implementing new strategies. Teachers then discussed ways to overcome these challenges. As such, in alignment with the MiFEC report (2020), the ARG meetings provided the opportunity for teachers to develop skills to address poor attitudes to learning.

These skills were perceived as complex. Resit students have experienced much failure in maths, and many did not see the point of resitting the GCSE. As one teacher mentioned early in the project:

"How to teach arrogant and disruptive students... sparkling and varied lessons don't work ...if they did there would be no problem."

Addressing such poor behaviour was paramount in most ARG discussions. As one mentioned:

"We need training to help us make the maths relevant to our learners, to engage them and be different from their past experience in school."

Teachers recognised that although struggle is often a precursor to learning, too much can also inhibit any learning. Getting the balance right can be a challenge and fear that students will behave badly may drive a more procedural, teacher-centred approach to learning. These concerns were similar to Swan's (2006) findings on what prevent teachers from implementing student-centred approaches. He found that teacher's low expectations of GCSE resit students to engage in rich resources encouraged a more teacher-centred approach.

The ARG group, however, were committed to adopting a more student-centred approach to learning. This was driven by the employment of formative assessment strategies and is aptly captured in the sentiments of one member:

"…I want to change from delivering to go to something that is more interactive…because it is more efficient…because I can see the misconceptions straight away…it is more engaging, and it is more fun for me and the students."

Furthermore, there was a positive change from comments in response to the initial Teacher Questionnaire when CPD was not recognised as directly supportive of their maths teaching to the results of the post-project survey:

"I have found the CfEM training to be much better quality and more relevant to me than anything else I have been offered here."

However, ARG members did acknowledge that consistently adopting a student-centred approach was hard for them and the wider maths team. There were several factors that inhibited such an approach, including the move from a centralised to a dispersed model of delivery. This meant teachers were faced with a new way of working and many had little time and energy to explore new approaches and challenge their own beliefs and current practice. Instead, many teachers relied on the familiar routines and roles in the classroom. Swan's (2006) view that a prescriptive scheme of work can promote a procedural driven approach to teaching was also echoed in the views of many CRC teachers.

Resources

An objective of the action research was to develop a GCSE Maths resit curriculum to meet the needs of resit students. The results indicate there has been some success in this undertaking.

The tasks were carefully selected to ensure they had some core characteristics. They were short, open activities that enabled teachers to find out quickly the current level of understanding of their learners. They generally had pre-designed differentiation built in and often included a visual representation.

The evidence indicates the tasks facilitated the move towards a more responsive, student-centred approach to teaching maths. In accordance with Ball's research (2008), the resources, and in particular diagnostic questioning, were key in developing teachers' knowledge of content and students in order to teach effectively. This includes understanding common misconceptions held by students and how to address them using multiple representations.

Teachers recognised the power of the resources. Collaboratively discussing them helped teachers see the potential of the tasks in ways they would not have done if reviewing the task in isolation. Such discussions helped to clarify the key learning goals and how to achieve them. As such the ARG teachers' experience of using the resources in the classroom, and subsequent collaborative reflections changed their beliefs in teaching and learning. It helped them teach in a different way, overcome the difficulties associated with student disengagement and challenged teachers' perceptions of learner capability. This aligns with Swan's (2007) study which describes how carefully designed tasks can help with changing teacher beliefs and shifting lessons from teacher-centred to student-centred. This occurs, not through persuasion but by teachers using the resources in their own classroom.

Within the ARG there was much discussion on how to sequence lessons, but teachers did not arrive at an overall conclusion. Such discussions were productive in that they developed another subdomain of pedagogical content knowledge: knowledge of content and teaching. This includes how to sequence particular topics in a scheme of work in order to facilitate teaching for understanding.

Participants recognised the importance of teacher guidance. Without such guidance it can be difficult to fully understand the purpose of the tasks. It was also acknowledged that just because there is guidance doesn't mean teachers would read it. Even if teachers did read it, their beliefs and priorities may result in misinterpretation of the potential learning embedded in the task. Discussing the tasks together, ARG teachers asserted, is by far the best way to clarify the key learning goals and how to achieve them.

Assessments were regarded as a key inhibitor to a shift towards a more student-centred approach. ARG teachers commented that it could promote coverage rather than deep understanding. This concurs with Ofsted's (2020) concern of teachers teaching to the test. Furthermore, the frequency of them promoted student disengagement, which was exacerbated if they were tested on topics they had not been taught.

Summary

In summary, the results align closely to the literature. Spillane (1999) cited in Golding, 2017, for example, argues necessary conditions for deep teacher change include a social rather than an individual 'enactment' zone, high-quality materials, and rich expert-supported deliberation that is grounded in classroom experience. This, the evidence indicates, has occurred at CRC, for the teachers in the ARG.

Conclusion and Recommendations

Collective teacher efficacy has emerged as the key theme describing the impact of the work of the Action Research group on collaborative planning. The safe environment built upon peer support has promoted the development of more open and honest conversations about teachers' experiences of trialling new resources in their own classrooms. This in turn has led to the empowerment of teachers to take risks and try new formative assessment approaches without fear of judgement by others. In turn, these classroom experiences and opportunities to share different insights from colleagues have caused teachers to change perceptions of potential learner engagement and capability.

The recommendations outlined here are subdivided into three parts according to prime audience: those that would be of interest to Senior Management, those that are pertinent to other FE colleges, including CRC and finally those for the attention of CRC teaching staff.

Senior Management

A student-centred Scheme of Work and assessment schedule that empowers teachers to use their professional judgement on when to move on to the next topic and maximise teaching time.

Facilitation of regular and sustained teacher remission with appropriate time slots to enable teachers to develop their practise in collaboration with others in a teacher learning community.

A whole college approach to maths teaching strategy, ensuring that staff, including the Quality Teams are up to date with "What good maths teaching looks like". This in turn could support their quality assurance.

FE College maths teachers, including those at CRC

Effective CPD requires a diagnostic approach. It is important to first find out where the teachers are at – what are their beliefs in teaching and learning. This information then can be used to guide the CPD. Swan's (2006) Beliefs and Attitudes survey is a useful tool.

Changing teacher beliefs and attitudes and ultimately improving their practise is not a quick fix. Small steps are appropriate in order to get early success and teacher buy-in.

Start with a small group of teachers who are open to exploring new approaches working on an issue that is important to them. Their enthusiasm and sharing of results will generate interest from a wider audience of colleagues.

The CPD should focus on formative assessment strategies driven by the refinement of good quality, short tasks including a focus on dialogic teaching and learning.

Creating a safe environment is key for teacher learning communities to develop collective teacher efficacy.

CRC teachers

CRC to support teacher professional development through the use of team teaching, a natural slow progression from this year's project.

External training providers, funded by the CfEM project, have introduced innovative ways of teaching. Tailored support facilitated by external maths consultant and time to discuss, and experiment is now needed to ensure sustained teacher development.

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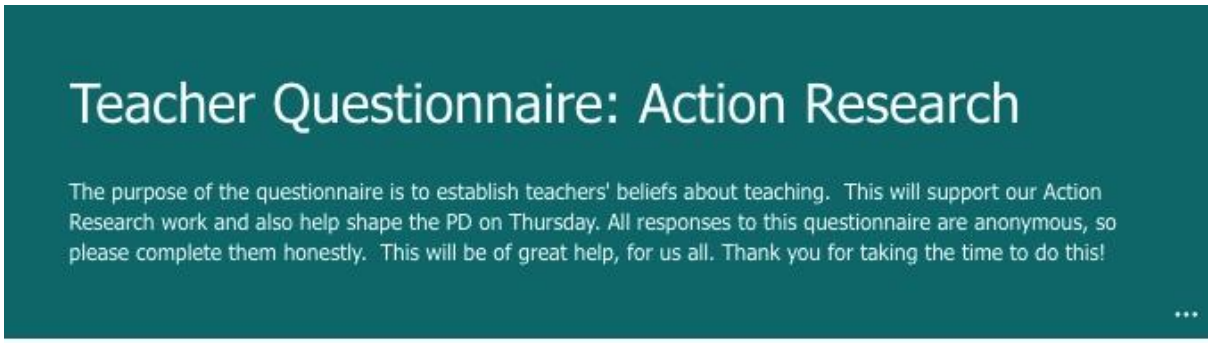
Appendices

Appendix A - Initial Teacher Questionnaire



* Required

1. Section 1: Overview of your work *

Rank in priority, which of the following activities, helps to maintain your enthusiasm for teaching

- Supporting and being supported by maths colleagues
- Helping students to achieve in maths
- CPD about maths teaching and learning
- Developing a student's confidence
- Developing a positive relationship with students
- Individually planning lessons
- Supporting and being supported by vocational colleagues

2. Please tell us about your enthusiasm for teaching *

Enter your answer

3. Rank in priority which of the following makes your work challenging *

Appendix B - Final Teacher Questionnaire

Maths teacher feedback - CfEM

...

* Required

1. Have you used resources within this year's maths Padlets? *

- ◯ Yes
- ◯ No

2. On a scale of 1 to 5, how useful have you found the Padlet resources? (1 not useful at all, 5 extremely useful) *

1	2	3	4	5
◯	◯	◯	◯	◯

3. What feedback can you provide about YOUR use of maths Padlets this year and the resources contained within them? *

Enter your answer

4. Compared to previous years, how have you found the maths specific training offered this year? *

Enter your answer

5. On a scale of 1-5, how much have you valued the maths specific training provided by the CfEM? (eg: White Rose, Maths Anxiety, Ratio Tables, Teacher as Researcher, Task Design - "Guess my Shape", "Laws of Arithmetic", etc) 1 = no value at all, 5 = extremely valuable *

1	2	3	4	5
◯	◯	◯	◯	◯

Appendix C - Teacher Diary

Action Research Teaching Diary 2020-2021

Please complete the diary each week, alternating between focusing on a lesson and focusing on the CPD sessions

Please complete it as honestly as possible – you'll get a lot more out of it this way

Diary entry for a lesson taught

From your week's teaching, reflect on a lesson in which you learned something, including a lesson/task/or question that went well, or didn't go as expected. It doesn't need to be momentous piece of learning, but try to select one that is focused, in some way, on formative assessment (e.g. an unexpected student question, or a realisation that students held a misconception, or students had a firm grasp of the concept. These incidents sometimes may have prompted you to change tack, ask further questions, or do something different either in the lesson or in future lessons).

Report on all lessons in which you used the diagnostic questions.

Week beginning: .....

1. Describe a critical incident in the lesson (or hinge moment), including how you responded.

2. If you used visual representations, how did they help you and your students?

3. What have you learned in the lesson?

4. How will your learning be used in future lessons?

Diary entry for a CPD session

When answering Q1. focus on your feelings, including your confidence, sense of being supported and/or supporting others, your motivation etc. The session may or may not have changed these feelings.

When answering Q2 and 3 focus, if possible, on formative assessment, including finding out about student understanding of an aspect of maths, or student motivation and confidence, and how to respond best respond to this new information in the classroom.

Week beginning: .....

1. How do you feel about working with other teachers?

2. What have you learned from the session?

3. Do you plan to use what you've learned in future lessons? Please explain

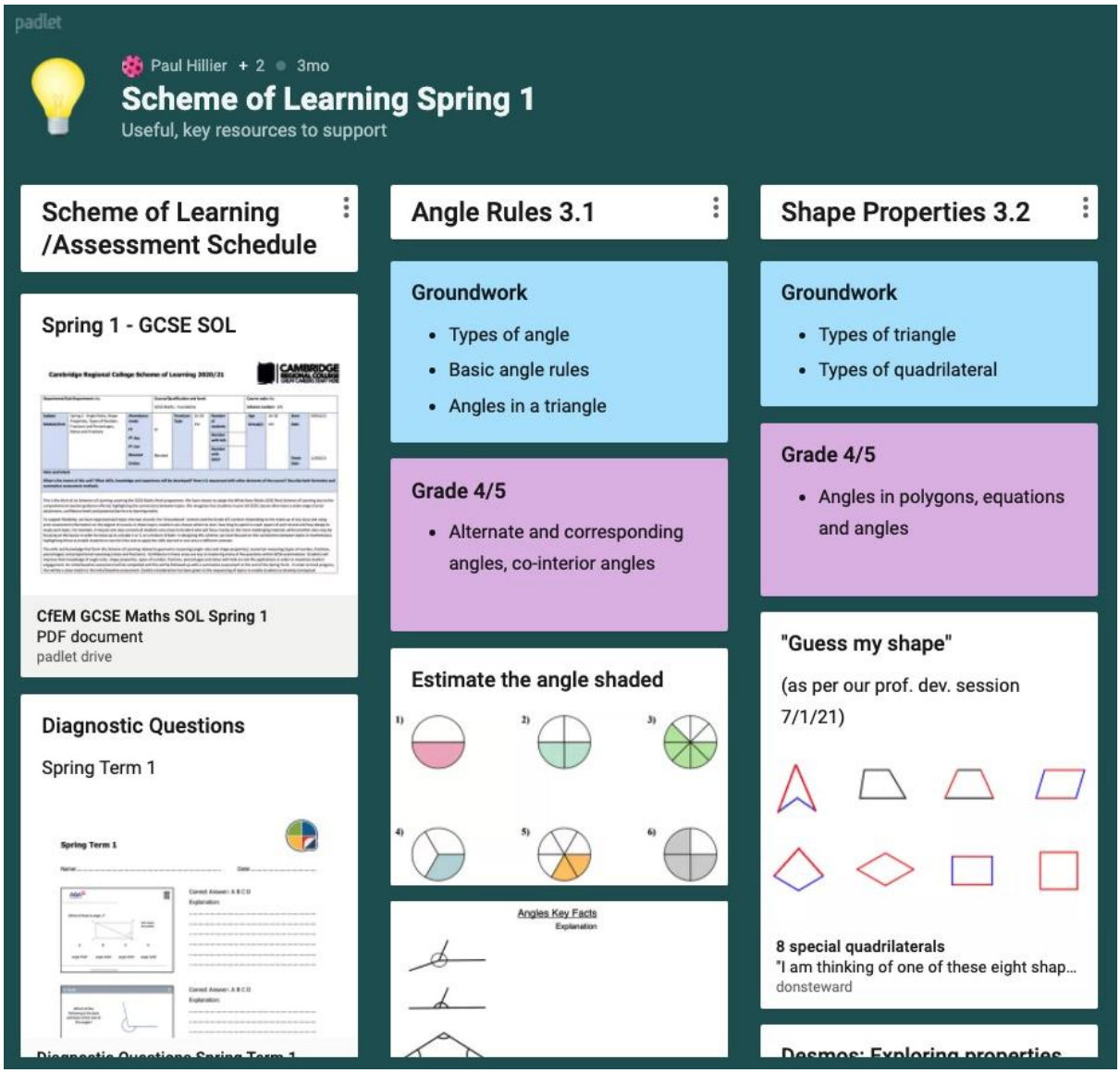
Appendix D - Example of Thematic Analysis

B	C	D	E	F	G	H
	Theme					
	Scheme of work	Characteristics of tasks	Collective efficacy	Teacher characteristics	Students /Groups	Future
Paul's got a question.						
Hey Monica, you're talking about from what I'm hearing, you are kind of moved away from a bit of a one size fits all approach. Not saying that's the way you were before, so my question to you is, do you feel? It was challenging having to kind of plan this way this year and how realistic is that that you have seven classes?						
Sometimes it is.I've got the general plan,so for this week, well, it dependson if it is beginning of something.I general plan and then I go to the class.I've got a few things and this istrial and error but will work and.Julie, you're on mute as well.Yes, sometimes it was.I went with one size fits all.If I was pushed for timebecause I found myself,you know with a lot of admin tasks,a lot of things to do.It was one size fits all.If I had more time where I could actuallythink about what I really want to achieve, then there was more focused on what task for what group. What would be good. But I must admit that I think most of the time it would have been one size fits all. Or if I've heard between the. Different groups, if I've heard something better, something that I found more interesting, more suitable than it was immediate change to try something different. But if I found myself sometimes lacking alternative explanation, you know, I've been taught things in a specific way, and if I don't have alternative way of explaining, apart from how I've been taught, this is where it. Sometimes it was apparent that. Learners didn't fully understand what I was talking about, 'cause they probably were told exactly the same thing, and the effect is that if it did not stay there. So that's a point to change. I don't know how yet, but that's the point to change.	Prioritising topics		Risk taking/doing something different	Pedagogial content knowledge		
So you're talking about pedagogical content knowledge,different ways of teaching, the same thing?Yeah,		Prioritising topics Planning for lessons Assessments openness College background				
yes. So it's really interesting because.You know I can relate having halfthe number of groups you've got.Of having sometimes to takea one size fits all but.Just sitting back listening to that.If we were all in the same boat,all of us and all the other stafftaking a one size fits all.Then we have to thinkabout whether whatWe've been talking about and what we're trying to achieve. I guess in terms of that. More personalized approach for classes is actually realistic, and the schem of work was set up to kind of try and enable that to happen, but if we've got teachers saying, well, actually I do the same thing for all of my groups anyway, every week. Then I think we need to be mindful of you know thatI think, being the issue. And that was why originally we wanted to move away from what we always had otherwise, in practice we're doing kind of what we've done over previous years anyway, because the the reality of it. Also, I think it's a really interesting. Honest answer that actually. I'm teaching the same to all my classes, which really. I mean, there's other benefits in the scheme of work. Don't get me wrong, but one of the big ones, as you've just said, is not following topics religiously. So. Just a few points I guess.	openness		Nature of talk			

Appendix E - Themes and codes

Theme	Code	Definition
Scheme of work	Prioritising topics	Deciding which topics are most important for students.
	Planning for lessons	What topics to cover, in what depth. Which resources to use. How and when to use them.
	Assessments	Formative, summative. When to assess.
Characteristics of tasks		
	Length of tasks	Deciding how much you can get from a task. Whether it will last for a whole lesson or more or whether it is a shorter task.
	Diagnostic questions	To establish depth of learner knowledge.
	Misconceptions	Common themes that learners believe to be correct.
	Adaptability of tasks	How a task can be modified to allow it to develop in different areas.
	Responsive teaching	Reflecting in action and changing the lesson plan during the session, depending on learner responses.
	Teacher guidance	Direction to enable the teacher to get the most from a resource or lesson.
Collective teacher efficacy	Empowerment	Teachers becoming stronger and more confident in their own practices.
	Peer support	Teachers supporting each other in a non-judgemental way to enable them to develop their teaching.
	Sharing ideas	Cross-fertilisation of ideas. People notice different things in a task. Looking at the same task in a different way.
	Honesty/truthfulness	This concerns teachers being open and honest in their comments - research shows this to be fundamental to good collaboration.
	Risk taking/doing something different	This concerns either trying out something new or being resistant to trying out something new. Being in a group can encourage risk taking.
Teacher characteristics		
	Teacher confidence	Teacher's confidence in their own delivery. That their lesson plans are correct for their learners.
	Teacher efficacy	Agency incl professional judgement.
	Teaching strategies	incl teacher change, pace of lesson and teacher/student centred approach (may need to be split out)
	Pedagogical knowledge	Teachers understanding of why they do what they do.

Appendix F - Padlet of resources

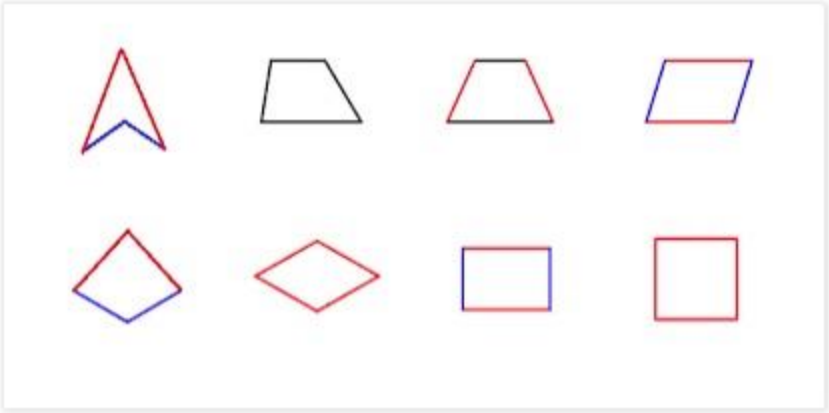


Appendix G - Sample task 1: Don Steward “Guess my Shape”

median
don steward
mathematics teaching 10 ~ 16

Thursday, 16 April 2009

8 special quadrilaterals



- square
- rhombus
- rectangle
- kite
- trapezium (trapezoid)
- arrowhead
- isosceles trapezium
- parallelogram

play 'guess my shape':

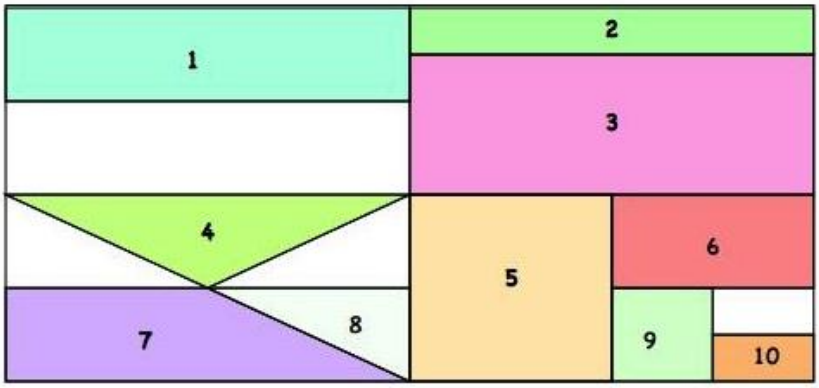
"I am thinking of one of these eight shapes
you can ask questions to find out which one it is but I can only answer yes or no to a question."

"What questions do you want to ask?"

"Now you have to try to find out my shape quickly - what questions do you want to ask?

"You can actually identify the shape in at most three questions.
What question do you ask first?"

Appendix H - Sample task 2: Nrich Rectangle Tangle



The large rectangle above is divided into a series of smaller quadrilaterals and triangles. Each of the shapes is a fractional part of the large rectangle.

Can you untangle what fractional part is represented by each of the ten numbered shapes?