How can guided reflection help GCSE resit students develop their problem-solving skills?

Sandy Mackay

Richmond Upon Thames College, UCL Institute of Education

This research explored how GCSE Mathematics resit student engagement during a guided reflection intervention could contribute to their problem-solving skills and confidence. Students were involved in individual problem-solving tasks followed by group discussion and reflective journaling. Themes emerged from a grounded approach to the analysis of the qualitative data and led to the theoretical grouping of students with similar levels of engagement. The *fully engaged* students demonstrated positive behavioural and appropriate emotional engagement, leading to cognitive engagement. This resulted in positive outcomes, supporting the literature. There was evidence in student journals that the *partially engaged* participants were aware of the thinking abilities of their peers and that this could lead to an understanding of how to use their mathematical knowledge and skills in more flexible and strategic ways. *Disengaged students,* who attended infrequently or participated minimally, maintained existing barriers to progressing their understanding of mathematics.

Keywords: GCSE; resit; problem-solving; engagement

Introduction

The researcher is an experienced mathematics teacher in a 'General Further Education (FE) College' for older students (aged 16-19 years), where English government policy in recent years has significantly impacted the number of students enrolled to (usually, re-)study GCSE Mathematics. The students involved in this study were from three post-16 GCSE Mathematics resit classes. After five years of secondary school mathematics, they had achieved only a grade 3 and so were required to enrol for the GCSE Mathematics course alongside their chosen vocational course. Grade 4 (formally grade C) is considered a pass grade and the participants in this study missed this target by one grade.

GCSE Mathematics pass rates and student numbers

National Joint Council for Qualifications (2021) data shows that since 2015 the summer pass (grade 4+) rate for GCSE Mathematics candidates aged 16 or under has been around 70%. This represents the rate for almost-universal secondary student GCSE entries. The pass rate for candidates aged 17+ has varied from 21.2% (2019) up to 38.6% (2021). As the 17+ pass rate includes mature students who have a higher pass rate than 16-18 year olds, progress for 16-18 year olds in FE colleges remains slow with only 18.2% achieving at least GCSE grade 4 in 2019 (Noyes & Dalby, 2020, p. 12). This is an unsatisfactory situation as the purpose of the government policy was to underpin the importance of mathematics and English in helping young people progress in their education and employment (Higton et al., 2017). Key findings from Higton et al. included reporting that motivation is low for many students and the importance of cultivating more positive student attitudes in order to improve students' motivation and attendance (2017).

Government funding requirements linked to GCSE resits have triggered a rise in the number of candidates from 77,501 in 2013 to over 165,000 each year since 2016, with the additional students largely taught in FE Colleges. Further, continuing low resit pass rates mean that most GCSE mathematics college students remain enrolled on GCSE mathematics for their two, and often three, years at college.

Literature review and research question

The cohort of English post-16 students compelled to study GCSE mathematics has existed only since 2014 and while this has enabled research into various aspects of their experience (Higton et al., 2017; Noyes & Dalby, 2020), the evidence base is still limited.

International research around mathematical problem-solving skills and pedagogy has been a well-established focus across the age ranges of students (Hacker et al., 2009; Quigley et al., 2018), although research is limited for our target age and 'threshold skill' for a confident pass in GCSE Mathematics (Higton et al., 2012). The enhanced specifications (Department for Education, 2013, p. 3) of mathematics GCSE subject content and assessment objectives reflected the intention to place a greater emphasis on mathematical problem solving, challenging candidates to identify the relevant data to formulate a plan, follow through the steps by applying their knowledge and then to deduce or infer the answer.

Guided reflection, which includes the observation of student discussions and the analysis of their journaling writing has been the focus of extensive studies across the age ranges (Bell & Bell, 1985; Waywood 1992; Hacker et al., 2009), although again, research is limited for our target age group. The discipline of journal writing to enhance understanding of these complexities has focussed on primary aged pupils (5-11 years), but there are exceptions where the journaling involves secondary or older students. There is a consensus that an ongoing use of journaling of their mathematical work deepens the students' mathematical understanding (Bell & Bell, 1985) and some studies support the assertion that disciplined reflection enhances the problem-solving process.

Much of the related literature is based on research with younger students. Those findings might, or might not, transfer to our cohort but it is possible that the relative maturity of post-16 students, alongside their experience of academic low achievement (Graham et al, 2020), will affect their engagement differently. The evidence from the literature review suggests that the progression, or even engagement, of GCSE mathematics resit students in relation to more demanding processes needed for effective mathematical functioning, such as problem-solving, remain a challenge but that approaches which include structured journaling within a supportive and metacognitively framed classroom, might have the potential to enhance their related learning. Therefore, my research question was:

- How can guided reflection help GCSE resit students develop their problem-solving skills?

Data collection and analysis

Fieldwork data collection

Six episodes of fieldwork for each class were planned, and the proposal received ethical approval. Each session would involve the students attempting individual problem-solving tasks followed by group discussions of how to solve the problems. Students would be guided to use affective words to describe how they feel during the tasks and would complete a journal entry to record their experience.

	Student journals	Teacher observation journal
Pre-launch **Mid-Nov 2019**	Not applicable	An entry for each class
Episode 1: **End-Nov 2019**	An entry per student Module 6 Module 7 Module 1	An entry for each class Mod 6 Mod 7 Mod 1
Episode 2: **Dec 2019**	An entry per student Module 6 Module 7 Module 1	An entry for each class Mod 6 Mod 7 Mod 1

Figure 1: Planned data collection

Figure 1 shows when the first two episodes of fieldwork were completed for each of the three classes, but unexpected events precluded further data collection. Data comprised 34 journal entries from 25 different students. Nine students completed two journal entries. There was also a researcher journal entry for each episode of fieldwork.

Analysis: the emergence of themes

The analysis of data focussed on themes emerging across the journal entries. The process of systematically obtaining and analysing research data can be described as a grounded approach (Glaser & Strauss, 2017) towards furthering the discovery of theory. Figure 2 captures the number of occurrences of emerging conceptual categories with examples from two of the three most popular categories.

Highlighter colour	Conceptual Category	Number of occurrences
Yellow	Learning from peers	1,2,0,1,0,0 = 4
Green	Listening/agreeing with peers	1,1,0,0,0,0 = 2
Aqua	Confusion from words	5,0,1,1,3,1 = 11
Pink	Poor writing skills	3,0,0,1,1,0 = 5
Orange	Reference to external factors	0,0,0,0,0,2 = 2

After a student solved the problem, I still did not quite understand it but I slowly started to realise how that student got the answer.

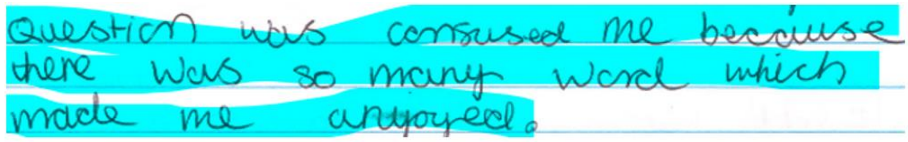
Question was consused me because there was so many word which made me anyoyed.

Figure 2: Emerging conceptual categories from students' journals.

Discussion and conclusions

Insider researcher and how that may bias/influence data

The role of the insider researcher brings challenges and opportunities. Kanuha (2000) identifies that a significant challenge for the insider researcher is the contradiction that they must maintain established positive connections whilst distancing themselves to the observer role. The advantages I claimed to have as an insider researcher were that I had immediate access to the participants, an established rapport, and a shared reference to interpret the data collected. The disadvantages were that I had to contend with my pre-conceptions and those of the participants about my role in the classroom. My ability to record observer notes while responding to additional demands supports Mercer's (2007, p. 3) argument that "what is lost on the swings is more than compensated on the roundabouts".

Language skills issues within the mathematical lesson

The modal category that emerged was 'confusion from words' in 11 of the 34 journals (32%). This covers unfamiliarity with the use of ordinary English words, technical terms, just too many words, or too demanding a reading level. Difficulty with words and limited language skills emerged as a barrier to accessing contextualised mathematics problems raising a question for further investigation. How does student engagement and performance improve with planned language development of mathematical words and phrases?

Collaborative learning versus individual learning

The researcher in this study observed the students collaborating to solve problems beyond their individual capability, supporting Noyes and Dalby's (2020, p. 10) recommendation 20 that "A broader set of performance indicators should be considered for post-16 mathematics education, for example confidence and self-efficacy".

Student emotions and engagement

Some students value the opportunity to continue their learning. My experience from listening to students is that some will say that they enjoy mathematics even when they get it wrong. Or they will say that they prefer the difficult problems because it makes them think.

In this study, most students readily cooperated with the introduction of a different lesson format. They attempted challenging problems, then participated in peer discussions and made journal entries reflecting on their experience. Their cooperation, compliance and participation were evidence that they can take a clear-thinking, mature approach to developing their knowledge, understanding and skills. This observed behaviour supports Graham et al.'s (2020) finding that older and more experienced students may benefit more from using a writing-to-learn activity, although this study did not include college students. There was also evidence from the student journals of disengagement from learning. Further, analysis showed learning around problem solving appeared mediated by student 'engagement', leading to a theoretical grouping of students with similar levels of engagement and a contingent response to the research question.

The fully engaged students (4 of 25) were able to demonstrate positive behavioural and appropriate emotional engagement, leading to cognitive engagement resulting in positive outcomes supporting the literature. They demonstrated that they had metacognitive skills in the episodes of fieldwork by using their acquired knowledge in a flexible and strategic way.

There was evidence in the student journals that the partially engaged participants (5 of 25) were aware of the thinking abilities of their peers and that this could lead to an understanding of how to use their own acquired mathematical knowledge and skills in more flexible and strategic ways. I argue that this group of students afford the greatest prospect of achieving better examination performance through the development of their awareness of their thinking abilities.

The disengaged students (2 plus absentees, of 25) did not appear to develop their abilities to solve problems or to be better prepared for the examination. Their observed negative behaviour, including infrequent attendance or minimal participation, maintained their barrier to progressing their understanding of mathematics.

These findings suggest that some of the research built on from other settings, also extends to at least some FE retake environments. The outcomes for the fully engaged and partially engaged students support research observations that facilitating student interactions with other students can be a key instructional resource and that acceptance by peers is linked to positive outcomes in secondary education, including satisfaction with school, positive beliefs about academic performance and its subsequent improvement (O'Donnell & Hmelo Silver, 2013). There is also support for research observations that students who participate actively in a group tend to learn more than students who are passive and that those who provide explanations achieve more than those who do not (Webb, 2013). The findings for the disengaged students support research identifying learners who do not actively seek help when needed (Webb, 2013) and have developed well-practised avoidance behaviours that have no positive social interactions (Webb, 2013). But these findings are limited as the fieldwork was curtailed and opportunities to examine contrary viewpoints, such as students engaged better because they were more confident of success, were denied.

The study therefore constitutes no more than a case study that suggests an intervention worthy of further exploration. Any such work is of course highly context-dependent, including being dependent on the particular teacher, and students, involved; nevertheless, it makes a small contribution to illuminating a possibly constructive way to achieve an incremental improvement in problem solving skills and confidence, for some students.

An obvious next question is what further investigation or research would develop the themes that emerged from the analysis and discussions in this study. The conclusions linked the level of student engagement to developing their understanding of mathematics and achieving better outcomes. How can we improve the engagement of the partially engaged and disengaged students in GCSE mathematics retake classes, and does this change lead to improved academic achievement?

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