The Researcher

Education Research projects by Researchers in Schools participants

Including titles such as **"Can structured practice improve science writing skills?"** and **"Speaking in 'CLIL': Improving progress and motivation in language learning"**.

Contents

Introduction

Researchers in Schools is the only dedicated route into school teaching for post-doctoral career changers in the world. Over the course of the programme, participants work toward the Research Leader in Education (RLE) award. The RLE award is designed to ensure that Researchers in Schools teachers are trained and supported to deploy the knowledge, skills and networks they have gained from their PhD to benefit pupils, schools, and universities in three important ways; by championing university access, increasing subject expertise and promoting educational research.

While working as a classroom teacher they have one day a week of protected time to complete the award. During this time, they work on a variety of projects that meet the three RIS aims above. This publication is the product of the education research strand of the RLE award. In their first year, participants complete an Education Research module. The module introduces them to methods of research, paradigms in social science and education research and some of the contemporary debates.

In their second year, RIS teachers deliver a pilot research project in their schools. We have partnered with Sheffield Hallam University, who deliver the Research and Development in Context module to our participants. RIS teachers get practical experience using mixed research methods and setting up a research project, while also gaining 30 master's credits.

Our teachers have summarised their projects' methods, findings, and analyses as well as any important insights and next steps. In this edition you can read about how study clubs can impact attainment and resilience, the impact of a targeted growth mindset intervention on white-working class boys' higher education aspiration and structured practice to improve science writing skills and more!

Dr Amy Calladine

How do study clubs impact on the attainment and resilience of Year 10 students?

Context

In a new school populated from the bottom up, the first cohort to embark upon their GCSEs did so without an established and visible cycle of formal examination modelled by older students. Teaching staff have voiced concerns about a lack of practical study skills and independent learning from students. From January 2021, the school started implementing interventions to address this specific issue including form-time revision strategies, working with external partners (Elevate Education), and running subject-specific study clubs (first sessions were planned for February 2020). The initial project looked to assess the effectiveness of these clubs by observing sessions in action, analysing assessment data and running focus groups with students and staff.

In recent years, there has been a rise in specific programmes designed to improve student metacognition, however, there has also been a marked lack of take up for these initiatives. This is most likely due to the fact that metacognition 'has not been a formal part of either the National Curriculum in England, nor a part of the recognised metrics used for accountability purposes' (Perry, Lundie and Golder, 2019, p. 491).

The Educational Endowment Fund (EEF) confirms that metacognitive interventions such as study sessions have consistently high levels of impact, with pupils making an average of seven months' additional progress. A range of systematic reviews and meta-analyses have found 'strategies related to metacognition and self-regulation' to have substantive positive results. Although most of these studies have focused on English or Mathematics, evidence suggests that findings are 'widely applicable' across a range of subjects (EEF, 2018).

The research suggests that effective metacognition in a school context

must be specific. It must help students 'to monitor, plan, evaluate and regulate their performance whilst completing a particular task'. These methods forward 'taught strategies' designed to equip students with an increased understanding of 'how to learn' as opposed to simply 'increasing knowledge'. Successful application of metacognitive strategies rests on the ability of students to confidently use them in a 'controlled, conscious way to solve novel problems' (Perry, Lundie and Golder, 2019, p. 485).

The wider goal of the project was to empower students to gain independent expertise through a range of effective cognitive strategies. Students who develop a wider range of skills to support their learning are much more likely to achieve success (Rogers and Hallam, 2009). As Zimmerman emphasises, effective learners are those that use multiple methods to help them learn. These include setting specific short-term goals, monitoring performance for signs of progress, managing time-use effectively and self-evaluating one's methods (Zimmerman, 2002). The study clubs at my school were specifically designed to help achieve these goals.

The Research

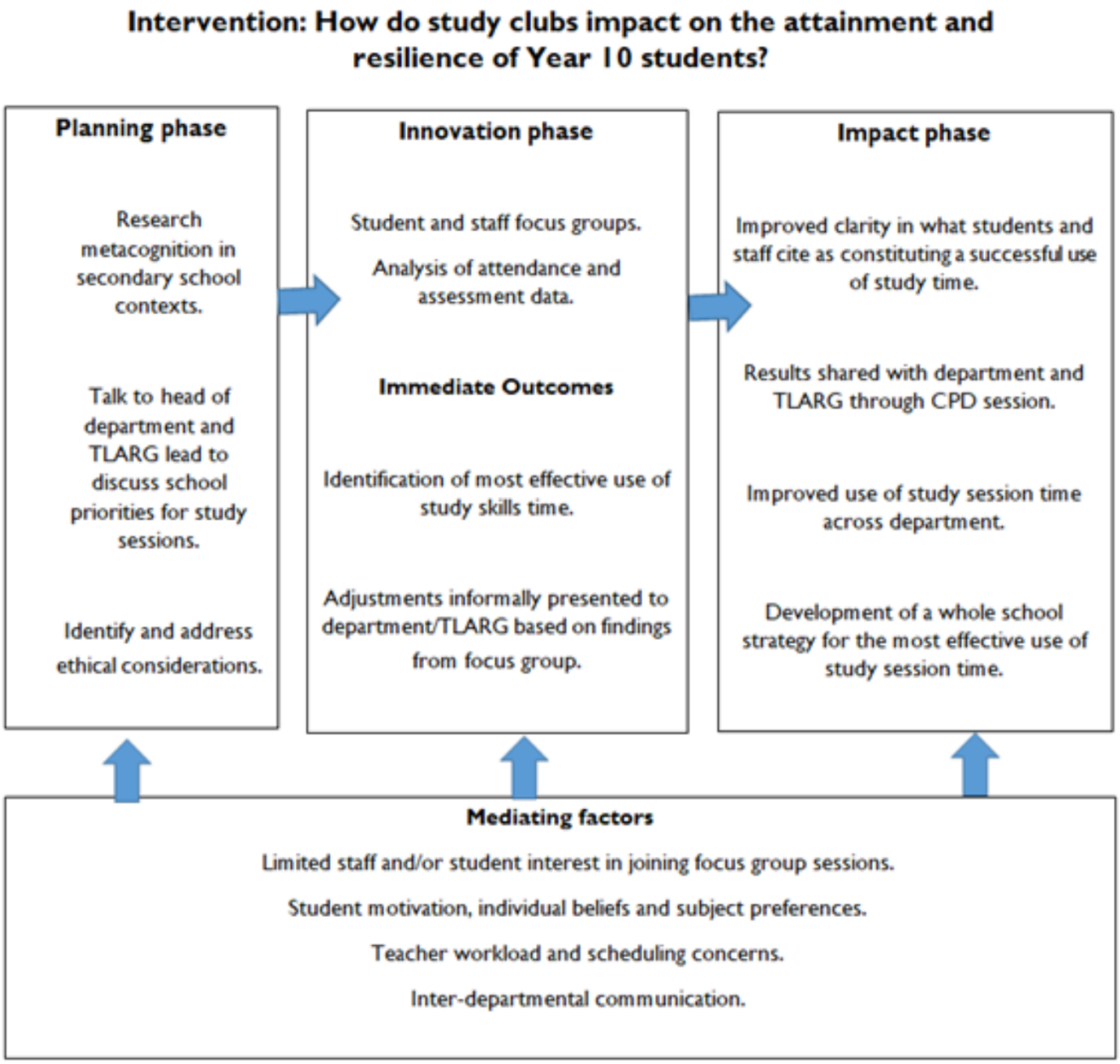
Research questions for the project:

1. What factors influence attendance at study clubs?
2. How do targeted revision interventions impact on student attainment?
3. How do targeted revision interventions impact on student confidence and resilience?

Adaptations

After the reopening of schools in September 2020, my school decided to change the format of its intervention. Rather than operating on a voluntary basis, the students in question (now in Year 11) were given a bespoke timetable which required attendance at three afterschool sessions per week which prioritised core subjects. The GCSE history sessions

were scheduled with class teachers to run three times over the course of a half term (three hours in total).
In light of these adaptations and successive school closures, the project shifted focus and became a more theoretical reading around the issue of applying metacognitive interventions in the secondary school context. In addition to planning an effective R&D project which can be rolled out in the future, I developed a logic model in order to explore the likely shape of the intervention, potential outcomes and predict any 'mediating factors' - unpredictable elements which may arise and interfere with results. A copy of the model is provided below:



Findings and next steps

The next step in the project cycle would be to execute the R&D project in reality, analysing findings and presenting results to staff in the school. Using the logic model outlined above, it is likely that there will be an improvement in the clarity of Greatfields' approach to managing the study skills sessions across subjects at Key Stage 4. The school will now have access to a bank of data on student and staff beliefs about what constitutes an effective session. This will also likely have flagged any points of confusion on the part of both students and staff which may need to be addressed as the school continues to grow.

As part of the impact phase, it will also be important to provide a more formal method of sharing results with colleagues. In the first instance, this will be with a specific presentation to the school's Teaching and Learning Action Research Group and the History Department.

Once results have been shared in this way, there is potential for findings to be integrated into future whole-school CPD with the overall aim that Greatfields might utilise the results of the project as a guiding document for developing a whole-school policy for ensuring the most effective use of study session time.

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Dr Dan Buxton

Building Exam Resilience for High Mark Mathematics Questions

Identifying the Issue

It is fairly common for 'a lack of resilience' to be cited as being an issue for particular students in the learning environment, although resilience is a fairly broad term that could potentially encompass a variety of traits or behaviours – some of which may be due to entirely non-academic reasons. Nevertheless, improving resilience is something that leaders of the school would like to put more focus on – 'resilience' is one of the key words that forms part of the school's ethic, after all.

In identifying the issue pertinent to this project, it was therefore essential to retain the idea of resilience, but to channel it into something tangible, manageable and specific to my expertise of mathematics. In my experience of observing lessons, marking assessments and getting to know students in maths lessons, it quickly became clear to see an underlying issue that was ubiquitous in maths classrooms, no matter what ability. If a single classroom task or assessment question got quite 'wordy' or long (i.e. lots of marks, typically accompanied by more than one sentence), students often threw in the towel.

Clearly, this is an important issue to address in the classroom, but when you consider the structure of maths GCSE examinations, it becomes apparent that if this 'low resilience' attitude were to be adopted in those examinations, a substantial proportion of marks would be lost, thus conceivably resulting in the difference between whole grades.

The specific questions that this applies to are known as AO3 questions. They are problem solving questions that rely on students being able to link several mathematical topics together, using multiple steps. The frustration is that in isolation, most students would be able to implement the skill that was being asked of them (i.e. if the question was presented in AO1 form), but it seems that adding context, more words or extra mathematical

steps gets in the way of even the parts of the question that they can do. Furthermore, AO3 questions often score zero marks or full marks, with 1 or 2 marks being much rarer than one would expect.

Aims and Purpose of the Study

The two main aims of this study are to diagnose and subsequently treat poor attainment in AO3 mathematics exam questions.

Diagnosis: It is important to understand why students have low resilience with AO3 questions rather than skipping straight ahead to designing an intervention that is potentially not fit for purpose.

Treatment: Based on the diagnosis, in-class interventions will be developed and implemented in order to improve AO3 attainment and ultimately enable students to earn more marks in GCSE examinations.

Research Questions

What do students perceive to be the barriers to accessing marks in AO3 mathematics questions?
To what degree does a lack of mathematical resilience inhibit AO3 attainment and will tailored in class intervention improve this?

The intervention

The main task in this session centres on the concept of goal-free problems. These types of problems typically exhibit AO3-style traits (such as diagrams and lots of text), but crucially do not have an end goal. That is, a specific question that points to a destination has been omitted. Students are encouraged to state as much as possible about the goal-free problem, no matter how simple or complex. This process relieves students of the pressure of producing a final answer and their focus fully turns to the process itself, which is typically where students fail to pick up marks in AO3 questions. Ordinarily, students would adopt a backward-working heuristic and would suffer a cognitive load at the subgoal stage that would prevent them from achieving process/method marks. This is referred to as the stage effect (Ayres, 1993). With goal-free problems, the subgoal becomes the main goal – cognitive load is reduced as a result of the problem no longer requiring multiple steps, and the path to the solution is therefore simplified.

The final stage of the intervention session reveals a link between students'

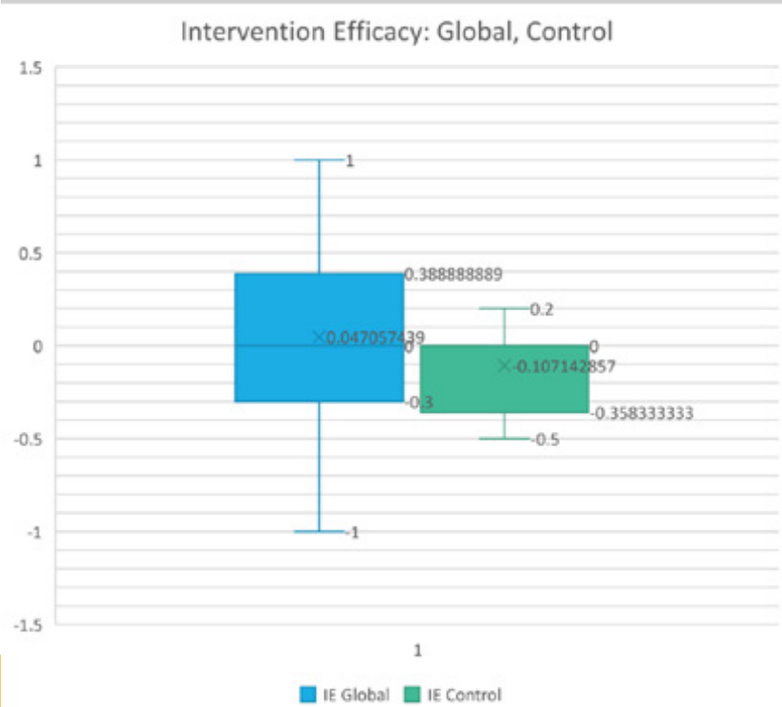
responses to the goal-free problem and the intended AO3 exam question itself. Students initially collaborate their thoughts and ideas about what information/goals they created, then the AO3 exam question is revealed, and finally students can link all the information they produced when 'the pressure was off' to the mark scheme of the AO3 question. In most instances, students realise that even without the final answer to the AO3 question, they have actually picked up the vast majority of marks by focussing on the process and ultimately leave the session with an increased sense of achievement and resilience because of it.

Findings

Thanks to a high absence rate in school, some students completed both assessments but may not have received the intervention in between. These students' results were therefore used as a control group (n = 7) and compared directly against those who did receive the intervention.

There was no statistically significant difference in mean IE, although with such few data points, this is not surprising. Based on the box plots themselves, it is promising to see that attending the intervention did seem to have a slight positive effect on IE

Table 1



Unpaired t-test

$H_o: \mu_G = \mu_C$

$H_1: \mu_G \neq \mu_C$

$n_G = 59$

$n_C = 7$

$p = 0.4278$

compared to the control group.

The project as a whole was geared towards some very deliberate intended outcomes. Based on observed results and subsequent conversations with department staff, it is pleasing to see that many of the intended benefits came to fruition, albeit to a statistically insignificant degree. The study has also experienced, however, some unintended positive outcomes which may not all necessarily correlate to the study itself, but are nevertheless beneficial for staff, students and the school going forward. In the intervention sessions, students were not expected to collaborate with peers during goal-free tasks, but after observing and leading some of the intervention sessions, I found that student collaboration helped to deepen topic understanding and provide a means of support, thus meeting the criterion of improving resilience. Staff resilience has not been the focus of this study, but I also found that communication between the department about resilience improved our receptiveness to new methods and ideas, which is something to nurture when discussing ideas going forward.

Conclusion

Whilst the intervention seems to have made a mild difference to accessing AO3 questions, it seems that stand alone interventions are not the desired format of delivery.

Instead, mathematical resilience (via AO3 exam techniques) should be woven into the curriculum and seen in lessons on a consistent basis in across all key stages. A resilience 'culture' needs to develop. Staff should design/use goal free problems more frequently, since most exam marks come from method/process over answer.

To a degree, mathematical resilience scales with mathematical ability. Hence, targeted strategies may be more worthwhile when used on set 2 and below (foundation and 'lower higher' students). Interviews/surveys/questionnaires would provide much needed qualitative data for this study and could have further informed the intervention design. Extending the study over a longer period would provide stronger conclusions, perhaps with statistically significant results. Using more participants for this study would have increased the statistical robustness when analysing results.

Dr Elisabeth Wallman

Can combining 'soft CLIL' and Extensive Processing Instruction enhance both progress and motivation in language learning?

Project Background

Although the UK government is currently seeking to increase the uptake of foreign languages in schools, the number of students opting for a foreign language at GCSE and A-Level continues to decline, particularly in state-funded, non-selective schools.

One common explanation for this decline is the rise of 'global English', which has weakened the economic and practical case for foreign languages for Britons (Lanvers, 2017; 2014), even as both government and employers' organisations have repeatedly stressed the dire need for language skills.

In fact, students mostly choose their subjects because they enjoy them, not for economic reasons (Wenchao, Muriel & Sibieta, 2011, p. 25). Repeated questions in my classroom, such as 'why are we learning French' and 'do we have to do this at GCSE', confirm that students question the value of this curriculum content. These pupil questions have provided the motivation for my study.

The Intervention

One approach that has been touted as a potential solution to reviving interest in modern language is content-and-language-integrated learning, or CLIL. This involves the teaching of another subject in a foreign language, with both language and content objectives. CLIL, then, allows teachers to use their foreign language to introduce students to content that is culturally relevant as well as cognitively challenging. Lasagabaster, in a 2019 summary of research on the effect of CLIL on motivation, actually documented a slight decrease in language learner motivation. Given the increased cognitive demand in CLIL, this is perhaps not surprising. CLIL on its own, then, did not seem like an appropriate

solution to the problem of low motivation I was facing in my classroom. A version of the communicative approach, Extensive Processing Instruction (EPI), that has increasingly gained traction in the UK has been developed by Gianfranco Conti, published in several books (e.g. Conti & Smith, 2016). Conti bases his approach on the findings of cognitive studies on memory, arguing that language teachers should 'teach less, not more' by focusing on the drilling of a limited set of language chunks.

Given its emphasis on reducing cognitive overload, this method is likely to succeed in allowing students to feel competent. However, its mantra of 'less is more' has attracted criticism from teachers for demotivating pupils by limiting their vocabulary and hence their ability to communicate on topics of interest to them (Determined Linguist, 2021).

The main research question guiding my project was whether a language teaching approach combining CLIL and EPI could enhance student motivation in year 8 learners of French (the age group when motivation in MFL dips), in the long term making it more likely that they will choose to continue with foreign languages at GCSE and beyond. I asked:

1. To what extent does an approach combining CLIL and EPI improve pupil motivation in language learning?
2. To what extent does it improve pupil self-efficacy?
3. Does combining these approaches balance out the respective

weaknesses of each (the challenging nature of CLIL; the banal, repetitive content of EPI)?

To test these questions, I designed a short intervention consisting in a five-week, two hours per week, programme of instruction.

The topic scheduled at departmental level was 'Going Out'. To deliver the language objectives from this topic, I decided to teach a course on the history of the French eighteenth century, a period which I had researched for my PhD studies and thus had expert knowledge on. I designed my intervention so as to equip students with the language needed to describe and explain the relationship between politics just before and during the French Revolution and aspects of the cultural history of 'going out' (which social groups enjoy which forms of leisure; fashion and politics).

Research Methodology and Design

I decided to adopt a mixed-methods approach combining pre- and post-intervention online surveys, in-class observation and journal entries written after intervention lessons. This diary included my impressions of what happened during the session, as well as reflections on key incidents and on students' contributions in the lessons.

Results

The evidence I collected is not strong enough to suggest a general increase in motivation, but there were observable changes among some participants. In particular, three students showed marked improvements in questions asking about both their enjoyment of, and self-efficacy in, French.

These results suggest that the approach tested in the intervention may not have the potential to increase motivation in all our students. However, given that the intervention was only five weeks long, an improvement in three students can be considered a success. Furthermore, nine out of fourteen students agreed or strongly agreed that 'Learning about the French Revolution has made France as a country more interesting for me'. This result is encouraging, as research in applied linguistics has demonstrated that perception of the target culture is one of strongest motivating factors in second-language acquisition (Dörnyei & Ushioda, 2009).

Further Research

Given my observations during the lessons, and some of the positive responses by students in their surveys, the approach I trialled for this project deserves to be developed and tested further. In particular, given that the intervention coincided with the national lockdown, I want to test the approach during in-person lessons, so that the effects of the approach itself are not drowned in the effect of an entirely different way of learning.

An important direction for further research is the role of teacher

motivation in the effectiveness of different approaches to language teaching. Policy developments have meant that teachers are less likely to experience autonomy in their own classrooms (Worth & Van den Brande, 2020). At the same time, the role of teacher motivation in affecting outcomes for pupils has arisen as a distinct field of study (Han and Yin, 2016). As a teacher, I felt more motivated to teach the CLIL course. Future research might ask how this increase in teacher motivation in courses that are based on both language and cultural objectives affects pupil motivation, especially in the long term.

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Dr Joe Oliver

White Working-Class Boys and Higher Education

Research Question
How do three sessions promoting a growth mindset impact on underachieving year 9 white working-class boys' aspirations for higher education?

Setting the Scene
Only 18% of white working-class boys entered higher education in 2017/2018 second only to Gypsy/Roma/Traveller ethnic groups (Department For Education, 2019b). The reasons for this have been discussed in (Baars, Mulcahy, & Bernardes, 2016) and have been collected in to four different categories two of which are attainment and aspirations. It is quite obvious that attainment is the biggest barrier to entering higher education as white working-class boys are the lowest performing group in our educational system (Strand, 2014). In 2018 only 14.4% of Boys who receive FSM achieved a grade 5 or above in both Maths and English compared to 19.1% of girls reviving FSM (Department For Education, 2019a). In the same year 42.4% of boys not reviving a FSM achieved a grade 5 or above in both Maths and English compared to 49.8% of girls not reviving FSM (Department For Education, 2019a). This shows a great disparity between the achievements of students who receive FMS and those who do not, but also between girls and boys. Although we are not using FSM as a proxy for working-class there are close links and considerable overlap of students who receive FSM and are PP (Ofsted, 2012). With regards to aspirations Baars et al. (2016) suggest that working-class parents are more likely to have low aspirations for their children and also "parents and pupils are less likely to aspire to go to university compared to their middle class counterparts" (Baars et al., 2016).

In this study we will focus on the students attainment and aspirations linking this with the potential 'mind sets' of the students: whether the

students possess a more growth mindset or fixed mindset. Students with a growth mindset believe that intelligence is malleable and can be developed by learning. Students with a fixed mindset believe that intelligence is something you possess and cannot be changed (Dweck, 2006).

The Research Project

The intervention applied in this study was closely modelled on that of (Yeager et al., 2019; Blackwell, Trzesniewski, & Dweck, 2007; Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2012) and was split into three 30-minute sessions. Some tasks were adapted from a growth mindset lesson plan (Khan Academy and PERTS, 2015). The first session focussed on neuroanatomy and neuroplasticity, introducing and discussing the role of neurons in the brain and reinforcing the analogy that the brain is like a muscle that needs training to become stronger. The session ended with a TED talk illustrating the power of belief and mindset. The second 30-minute session was delivered a week after the first where participants were then asked to complete a mathematics task using mini-whiteboards. This task, titled 'Four 4's', has been credited as a task that promotes growth mindset (Boaler, n.d.). Participants were encouraged to find as many different solutions as possible during the task and were asked to come up to the board to write their solution on the board. If a participant wrote an incorrect solution they were encouraged to check their solution, hopefully learning from criticism. The third session was focussed on discussion and motivation. Participants discussed the significance of the fact that the brain can become stronger with exercise and training. Personal stories were shared from teachers and participants of times when they had to work hard to achieve their goals. Many of these stories focussed on being inept at a task but through trial and error, training and failing they succeeded. This session closely followed that of (Blackwell et al., 2007) but on a smaller scale.

I hypothesised that the intervention would shift participants' perspectives towards a more growth mindset and that the shift would also modify the participants' aspirations to attend higher education.

To measure the effects of the intervention there were two questionnaires completed by participants. The first questionnaire was a baseline questionnaire which was based upon the Implicit Theory of Intelligence Scale (Dweck, Chiu, & Hong, 1995) were to assess if the participants

possessed a fixed mindset or a growth mindset. There were also questions to gauge the participants' aspirations with regards to higher education. To compliment the questionnaires and to analyse any tangible effects of the participants potential shift from a more fixed mindset to a more growth mindset, maths homework data was harvested. This data will also be used to assess if the students attainment was effected with the potential shift to growth mindset.

Results

Participants - The study took place in a year 9 classroom in a secondary school situated in a deprived suburban area and was introduced to 18 low attaining year 9 students. Of the 18 students, all students were of white British declaration, 11 were boys 7 were girls, 13 were PP of which 8 were boys and 5 were girls. Consent was given by 10 students and due to the ongoing COVID-19 pandemic some of the consenting students had to self-isolate. Due to this only 6 participants were included in this study. Of these 6 participants 3 were male and 3 were female, 2 were PP and only 1 participant fell into the target demographic of white working-class boys. Due to only one participant being in the white working-class boys category this will greatly limit any conclusions that can be drawn from the effect of the intervention on this demographic. Some conclusions could be drawn as to the effect of the intervention on white working-class or low attaining white British students removing the focus on boys and/or working-class.

Findings - This study was able to analyse the impacts of the intervention on the students mindset and their aspirations but students attainment was not accurately measured due to the limitations on the homework data. What can be said is that the intervention may have had a slight positive effect on the participants aspirations and expectations and also there is a correlation between participants mindset and their aspirations with regards to higher education. All participants with a more fixed mindset also had low expectations and aspirations with regards to higher

education. Conversely, participants with a more growth mindset had higher expectations and aspirations for higher education corroborating the findings of (Degol, Wang, Zhang, & Allerton, 2017; Huang, Zhang, & Hudson, 2018; van Tuijl & Walma van der Molen, 2016; Liu, Robinson, & Xu, 2018).

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Dr Monday Agi

Enhancing Students' Learning Progress in Science using Effective Formative Feedback Technique

Introduction

Formative feedback should answer the following questions: "Where am I going?", "How am I going?", and "Where to next?" (Hattie & Timperley, 2007), Thus, if provided thoughtfully, formative feedback is known to be a highly valuable intervention tool (Schütze et al, 2017).

However, not all feedback is effective (Harks et.al, 2013). It is therefore imperative that feedback techniques are robust enough to ensure effectiveness, especially in the study of science among secondary school pupils.

This study therefore seeks to evaluate how teacher-feedback on extended questions in science can be improved to help students master scientific concepts, enough to apply acquired knowledge and skill in an unfamiliar context.

The Problem

According to the GCSE Result Insight Report (AQA, 2019), the performance of students nationwide showed that in the physics foundation and higher tier paper 1 and 2, extended writing questions were attempted by the least percentage of students - 41% and 29% respectively. This indicates a significant lack of confidence or requisite skill to attempt extended writing questions in science.
Also, extended writing questions are often reported as the questions that students often find to be the most difficult (BBC Bitesize, 2021).
In the researcher's school context, data from the summer half-term formative assessment for year 9 students (the case study class for this research) showed that out of a total of 170 students that took the test, 75% of the students attempted question number 3, which was an extended writing question. Out of these, 86% (111 students) of them

scored below 3 marks (half of the total score) and 41 students, which represents 24% of the total number of students did not even attempt the question mainly due to lack of confidence.

Research Question

How can feedback on exam-style extended writing questions in science be improved to help students master scientific concepts, enough to apply acquired knowledge and skill in an unfamiliar context?

The main objective is to identify an effective feedback technique that will support the following outcomes among students.

1. Confidence in providing extended response.
2. Better or deeper understanding of scientific concepts
3. Knowledge transfer to new context.

The intervention

There were three steps in the intervention, which allowed for a systematic data collection approach to the study as outlined below.

Step 1: Participant's selection

Consistent with the recommendations of King, (2002) and Hardin & McFarland, (2000), 12 students were randomly selected through a ballot system out of 20 volunteers as adequate sample size given the nature of the research as a small-scale study.

Step 2: Presentation and assessment

After a short lesson on "Thermal Insulation of Homes", the students were given a formative assessment, an exam-type extended writing question (6marks). These students' works were collected and graded accordingly without disclosing the scores to the students. Although 12 students were initially accepted for the research, only six attended the intervention session.

Step 3: Feedback session

Three different forms of feedback were provided to the 6 attending students in groups of two. All feedback followed the strong recommendations of Davies (2011) regarding clear explanations of success criteria.

- **Group 1:** (current technique group), This group followed the current

process used in the school's science department, where a green sheet containing generic checklist of "what went well" (WWW) and "even better if" (EBI) is placed on student's work, from which they re-write answers with improvements.

- **Group 2:** (peer marking technique group). This group of students were given a clearly explained mark scheme. Afterwards they peer-marked their work using the mark scheme rigorously.
- **Group 3:** (self-reflection technique group). Students individually marked their work using the mark scheme. Following this, they were also asked to write a reflection, detailing what went well and what could be improved on.

Following these, the students were giving the opportunity to retake the initial assessment as well as answer another question framed in an unfamiliar context.

Gathering the data

To ensure greater validity of the research findings in this study, an integrated or mixed research method was used which involves collecting quantitative data and qualitative data (Hafsa, 2019) - a short and simply worded questionnaire, consistent with the suggestions of Saunders (2016), for high impact, and a semi-structured interview with the students for more details which helped the researcher to gain better insight for valid analysis (Moriarty, 2011).

The differences in the students' marks in the exam-style extended question assessment before and after the intervention (feedback session), their answers to the questionnaire, as well as the interviews, have provided the data for analysis in this study.

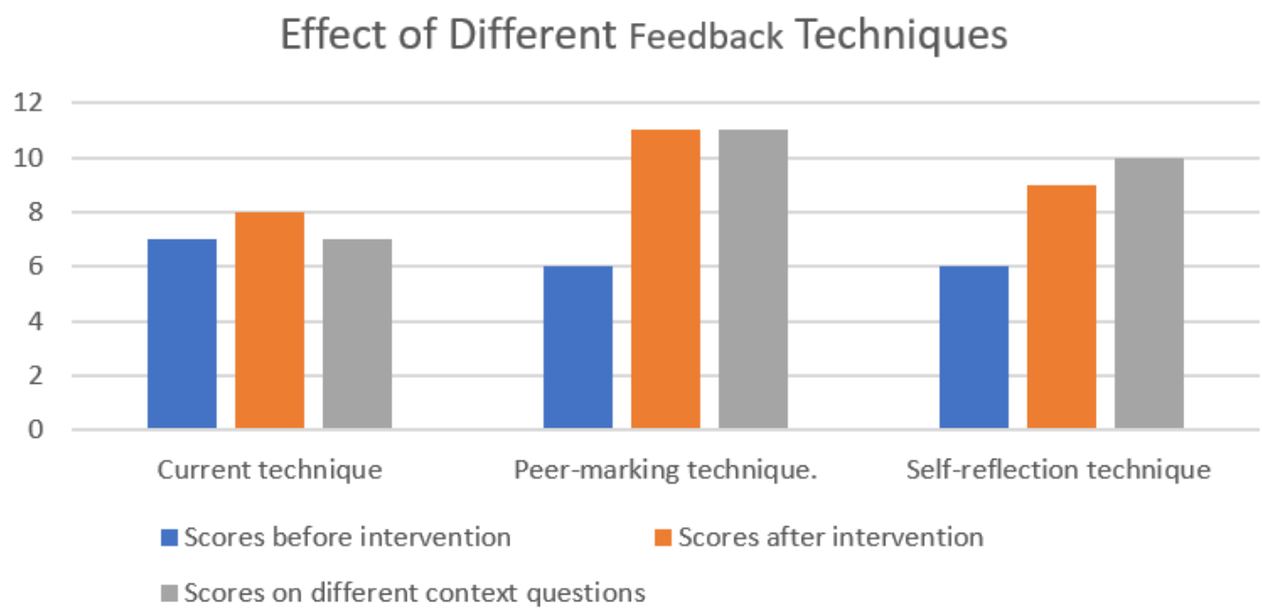
Data Analysis and Discussion

In this study, three feedback techniques were tested in an intervention against three themes or outcomes, which include, Confidence in providing extended response, Better understanding of topic, Knowledge transfer to new context.

Current Technique

When tested against others in the intervention as presented in Figure 1 below, there showed a low improvement rate among students. While there was marginal increase of 8.7% (1 mark) between the scores achieved before and after intervention, there is however no noticeable change between the scores before intervention and the scores achieved when the different context question was answered. This result directly implies that this technique is evidently not very effective in supporting student to respond to questions framed with a different context.:

Figure 1: Effect of different feedback on students' scores in an extended answer formative assessment (total scores from of students in technique groups from Table 2)



Peer Marking Technique

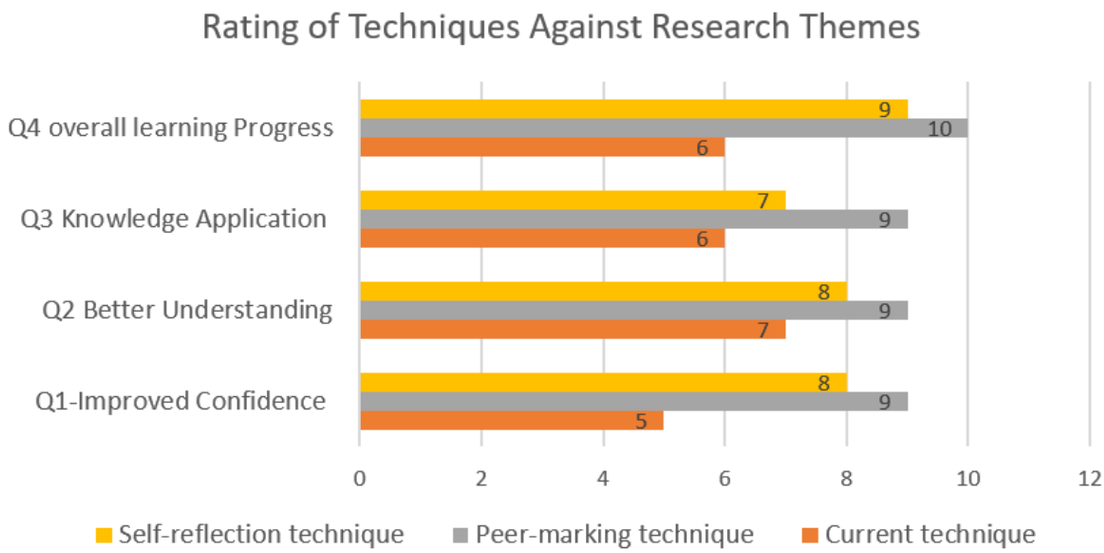
Also shown in Figure 1 above are the comparative scores for the Peer-Marking Feedback Technique. This reveals a significant improvement in the students score before and after the intervention. An increase of 41%. Also, the figure shows a 100% score on the different context question by the students in this group. This goes to show the potency of this feedback technique with regards to deepening the knowledge and confidence of students. This technique is therefore seen to be very effective.

Self-Reflection Technique

Again, Figure 1 above also indicates that the Self-reflection Technique records a considerable increase in the scores of students before and after

the intervention accordingly by 25% (3 marks). Also recorded was an increase in the students' ability to confidently answer other question on the concept even when framed with a different context. This implies that the Self-Reflection Techniques can be seen as potentially effective.

Figure 2: Rating techniques against research outcomes/themes



Additionally, Figure 2 above from the questionnaire, shows a clearer comparative picture of the impact made by the different techniques tested in this study. Overall, it is evident that Peer Marking Technique proved to be the most effective technique as it scored highest in the three outcomes as well as the overall outcome.

A major characteristic of this technique is the direct involvement of the students in the feedback process.

Conclusions and Recommendations (Slide 12)

This research therefore constitutes an attempt to identify the most effective way of providing feedback to students on extended writing in science. Here are the conclusions and recommendations.

1. The most effective formative feedback technique among the tested was the Peer-Marking Technique. This feedback technique supported students' progress across the three measured outcomes. From the insight

provided in the interview, this result can be attributed to the opportunity it provides for student's direct involvement in the feedback process, consistent with the recommendations of Fluckiger et. al, (2010). It is therefore recommended that Formative feedback on extended writing in science include more students' directly involvement.

2. The 'Current Feedback Technique' used by the science department in the school is judged to be the least effective. It is seen to be mostly generic and does not cater for the specific needs of individual students.

3. A combination of peer marking and writing self-reflection on 'what went well' (www) and 'even better if' (ebi) before attempting a re-draft is recommended as this helps the student to take responsibility for both the process and the outcome.

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Dr Peter Blythe

Can structured practice improve science writing skills?

Why is it that Science students who can predict the outcomes of experiments, perform calculations and express their understanding in conversation often have difficulty expressing that understanding in writing in a sufficiently precise and unambiguous way to score marks in GCSE or A-level examinations?

The importance of this issue is clear. My survey of GCSE exam papers showed that 61% of all available marks required a written answer of at least sentence-level complexity. The single command word explain accounts for 20% of all questions and 30% of all available marks.

Yet there are few readily available resources to help teachers develop students' science-specific writing skills. Common textbooks do not focus on this. Mark schemes for exam questions encode requirements for precise writing in brief descriptions of 'levels' of response (left to expert interpretation and adjudication), while far more space is given to content-centric 'indicative content'. It is difficult to blame teachers and students for concentrating on content knowledge feedback rather than sentence construction.

Analysing the problem

Linking my study of the examination requirements to my students' work, I identified common sentence structure errors that prevent students achieving full credit for their answers, exemplified in Table 1.

Type of sentence	Correct example	Common errors	Incorrect examples
Factual statement (State... or Give...)	Water boils at 100 °C.	Unclear referencing. Missing units when giving data.	It boils at 100.
Comparison (Compare...)	The water is hotter than the ice.	Unclear referencing. Making absolute rather than relative statements.	It is hotter. The water is very hot.
Explanation (Explain… or Why…?)	The volume of the gas increased because it was heated.	Making statements without causal linking. Inverting cause and effect.	The volume of the gas increased. It was heated. The gas was heated because its volume increased.

Table 1

These specific types of sentences can be broken down into component parts, as shown in Table 2.

Command word in exam	Type of sentence	Example sentence templates	Example sentences
State… Give…	Declarative factual statement	The [noun] is [adjective]. [noun] is a/an [categorical noun].	The apple is red. Aluminium is a metal.
Compare…	Comparison - differences	The [noun] is [comparative] than the [noun]. [factual statement] but [factual statement]	The man is taller than the boy. The apple is red but the pear is green.
Compare…	Comparison - similarities	[noun] and [noun] are both [adjective].	Ammonia and sodium hydroxide solution are both alkaline.
Explain… Why…?	Causal explanation	[factual statement] because [factual statement]. [factual statement] because [comparison].	Ammonia turns red litmus paper blue because ammonia is an alkali. Aluminium melts in the oven because the temperature of the oven is hotter than the melting point of aluminium.

Table 2

The table shows that the basic building block of these sentences is the factual statement, extendable with "comparing words" to form comparisons. Factual statements or comparisons can be joined with "because" to form causal explanations.

This provides a model suitable for a long-term Deliberate Practice approach (Ericsson, 2006) by first practicing simpler types of sentences, then combining these to produce more complex sentences.

Designing an intervention

A meta-analysis of studies on writing instruction in secondary students (Graham & Perin, 2007) includes three techniques used in the intervention worksheets: setting clear and specific goals for what students should achieve in their writing (effect size d = 0.70); instruction in sentence combining (d = 0.50) (Saddler & Asaro-Saddler, 2010); providing models for each type of writing (d = 0.25).

The worksheets also use more general evidence-based methods (Hattie 2008, 2015, 2017). Their long-term use contributes to a Deliberate Practice approach (effect size d = 0.79), the worksheets use scaffolding (d = 0.82), setting clear learning goals (d = 0.62), and self-assessment (d = 0.75 for "evaluation and reflection") by checklists (Gawande, 2011).

Combining these methods, each worksheet shared a common structure of rules and examples first, then sentence construction from templates, followed by free-answer questions each supported by a self-assessment checklist.

The main research question became "Does the structured practice of specific, fine-grained writing skills improve attainment in GCSE-style written answers in Science? Does it have a larger effect compared to practice using past-paper questions?"

To test this, I used a randomised, controlled trial. Students in a middle-achievement Year 10 class who consented to take part in the research were randomly divided into 2 groups. The control group (n = 10) practiced and received feedback on past-paper questions, using the official mark schemes. The intervention group (n = 9) used the new worksheets. A test of past paper questions was set before and after the intervention.

Results and outcomes

The intervention group showed a larger, but not quite statistically significant, improvement in test scores ($d = 0.71$, $p = 0.09$), while the control group showed a smaller, less significant improvement ($d = 0.37$, $p = 0.23$). No statistically significant difference between the groups could be detected, though the intervention is promising given the small number of participants and merits further investigation.

Both groups had trouble decoding the test questions. For one explain question a majority of the answers were descriptions or comparisons, which scored no marks. This highlights the need for more support on question decoding.

One student spontaneously began using one of the study's checklists in other lessons. My observations also showed checklists supporting self-evaluation and assessment awareness. Combining this with the need for support in question decoding, I produced laminated (wipe-clean) checklists for each common command word in written questions. My students now use these for checking sentences, with positive effects.

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Dr Sally Malik

The requirement of mathematics in science

Understanding and engaging with mathematics is a fundamental part of any pupil's science education and paves the way for a fulfilling career in a wide range of STEM professions [1]. However, pupils regularly perceive mathematics to be difficult [2], many acquiring a defeatist attitude and simply believe "it is ok—not everyone can be good at math" [3].
As classroom practitioners we simply cannot let this attitude manifest. Mathematical skills make up 20% of marks awarded for the combined science GCSE [4]. For the single science GCSEs, marks for mathematical skills make up a minimum of 10% in biology; 20% in chemistry; and 30% in physics [4]. Therefore, to achieve top grades in their science GCSEs, pupils not only have to be accomplished scientists but also proficient mathematicians.

The problem with mathematics in science
The science curriculum is content heavy, with pupils required to remember and apply a large amount of knowledge in their GCSE examinations. Time pressures of delivering the high knowledge content of the science curriculum can mean that pupils fail to achieve mastery in mathematics problems. Information has not had the required time to be processed and transferred into the long-term memory, where it can be recalled later [5]. Pupils quickly forget how to answer science-based mathematics problems and fail to recall and rearrange equations.

Promoting remembering with retrieval practice
It would be logical to hypothesise that incorporating more opportunities for practice of mathematical problems in the science classroom would lead to enhanced understanding and retention of these concepts. "Practice makes perfect" has long been highly regarded in the field of neuroscience, with repetition or practice of a skill leading to increased myelination of nerve fibres [6]. The speed at which nerve impulses are transmitted are enhanced resulting in improved progress and attainment

of that repeated or practiced skill [6]. This can be accomplished through retrieval practice, a highly regarded and successful evidence-based strategy requiring pupils to recall knowledge from their memory with little or no support [7]. Retrieval practice incorporates "desirable difficulties" into the classroom, aiding knowledge retention and improves learning [8]. Through retrieval practice, information is more likely to be transferred into the long-term memory, thus strengthening pre-existing schema [9] and has been shown to facilitate mastery of new information [10].

Evidence suggests that testing via retrieval practice can lead to a 21% increase in final assessment scores [11], significantly more effective than rereading [12] restudy [11], note-taking [13] or even elaborative study [14]. This is because these study techniques lead only to short-term learning, with information not being transferred for storage and recall in the long-term memory [7].

Studies have shown that practicing mathematics problems after a delay can significantly increase long-term knowledge retention [15-17] by increasing storage strength [18]. This spacing introduces an element of forgetting thereby increasing the level of desirable difficulties [8].

Implementing maths retrieval practice in the science classroom

So as not to impact significantly on teaching time, which is already at a premium in the science classroom it is suggested here that retrieval practice take the form of a low-stakes quiz. This format has been shown to significantly enhance performance in end of topic and end of unit assessments [19-20]. In a meta-analysis of 222 independent studies, retrieval practice via class quizzing consistently enhanced academic performance by approximately 83% [21].

A five-minute quiz can be given to pupils at the beginning of each science lesson. For maximum impact, the quiz should be followed by feedback, so pupils understand what they know and the gaps in their knowledge. Immediate feedback can also increase knowledge transfer to different contexts [22], for example between maths and science. Retrieval practice quizzes should be designed to test skills covered in the previous lesson (2 questions) and prior learning (3 questions), to incorporate the benefits of spaced practice.

Assessing impact

It is advised that any practitioner wishing to implement a maths retrieval practice intervention in their classroom assesses its impact on pupil progress and attainment in the following ways:

1. Pupils sit a pre- and post-intervention maths assessment. This allows comparison of maths ability at the start and end of the intervention to determine the overall effect of the retrieval practice intervention on knowledge retention and recall. A control class with similar demographics and range of abilities should be chosen, that would also take the pre- and post-intervention assessment but not take part in the retrieval practice intervention. This should ensure that any enhanced testing effect observed is due to the retrieval practice intervention and not due to familiarity of the assessment.
2. Pupils answer a pre- and post-intervention questionnaire. Pupil's feelings, experiences and/or perceptions of the retrieval practice intervention can be assessed via a questionnaire. They are also useful tools in uncovering factors hampering pupil progress and attainment that would missed if relying only on quantitative data alone. For example, many pupils suffer from "maths-anxiety", a debilitating and often psychologically routed problem severely effecting self-efficacy [23]. However, retrieval practice has been shown to reduce end of unit test and exam anxiety by 71% [24], therefore, it could be envisaged that maths-anxiety may also be diminished.
In addition, interviewing some pupils may elicit a fuller picture of their views, beliefs attitudes and opinions of the retrieval practice intervention.

Next steps

Previous studies have shown that for low attaining pupils, answering multiple-choice questions led to a subsequent testing effect which was lacking for the high attaining pupils [25]. Interestingly, performance of all

pupils was negatively affected when elaborative interrogation questions were set. Other studies have explored whether designing retrieval quizzes based on areas of weak performance in prior exams could lead to a greater testing effect [26]. Therefore, it would be prudent to investigate if and how the testing effect varies depending upon pupil ability and how the quiz design might also influence the outcomes of the intervention.

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Dr Steven Watts

Self-Directed Learning: Do Students Learn Computer Science Effectively When They Are Given Responsibility For Their Own Progress?

Whether it's how to work with new software or taking on a role that didn't previously exist, the ability to learn and direct your own learning is one of the most important skills a person might achieve. It remains an unfortunate circumstance, that formal education and students' experiences in schools, don't always prepare students for eventually going it alone. In- deed many students are dependent on a rigid school structure to direct their learning, which although necessary in earlier years, becomes less relevant for some students as they mature into adulthood. This therefore presents an interesting case to consider for students on the boundary, namely those completing A-level studies.

Self-determined learning is the ability to take responsibility for one's own education by discovering what is necessary to learn, setting learning goals, and selecting the most appropriate learning strategies. Additionally it may become necessary to evaluate one's own learning outcomes. Self-directed learning may share many of the same principles as traditional education, but comes with a whole new set of skills. The growing movement towards including elements of self-directed learning in the school curriculum, is based on the idea that students learn best when learning arises from genuine in- terest. There is growing evidence that this process gives students a deeper understanding and appreciation of their subject. Pupils often learn by do- ing, and the joy of the wisdom they have earned is experienced through exploration and discovery.

There have been numerous studies completed on the topic, showing varying degrees of success in suggested methods for providing a self-directed envi- ronment, in addition to methods of assessment. One such study showed a failure rate reduced from 19% to 13% and a withdrawal rate reduced from 31% to 19% for students who participated in the study (1). The study high- lights a particular success within this field, and further

identified three key areas of focus when considering the development of a self-learning course. Namely: content delivery, peer support, and progress monitoring.

The optimal structure of self-directed courses is still up for debate, and may vary depending on the course material. Amongst these debates, is the question of whether a bottom-up or top-down content structure is most suitable for teaching coding skills. Coding has historically been taught using a bottom-up approach, where details of syntax and the use of objects, data structures and classes are the primary concepts being taught. However the alternative top-down method, the subject of one particular study (2), instead focuses on students understanding the key concepts more abstractly first, prior to understanding the specifics of implementation.

Additional debate focuses on the question of whether self-directed courses should focus on including group sessions, or instead keep the student en- tirely independent in their work.

One study focused on evaluating dropout rates for the duration of a course, when group work was emphasised (3). The teaching model incorporated continuous group feedback as part of a CS programming course, and saw dropout rates decrease significantly. A further study, the Self-Paced Learning Increases Retention and Capacity Project (SPARC) (4) considered the question of group work in additional detail. The SPARC project involved the creation of a self-paced learning en- vironment that incorporated group work into the online learning experience. Students were encouraged by the project to trial their software in groups, in addition to learning the course content at their own pace. The SPARC project additionally assessed the impact of self-paced learning rather than fixed deadlines, and considered the effect this had on student learning.

Many studies focus on the above issues, and further consider what the most important focus of a self-directed course might be. One study

concluded the following important considerations when designing self-directed courses (5): The challenge of supporting students' theoretical synthesis, the individual's opportunities for self-direction in a group work setting, the mismatch be- tween individual learning processes and academic course scheduling. Again, group work appears as a key focus for a self-directed learning course, in addition to the usual expectations of asynchronous learning.

Similar conclusions were also reached within a study of 49 primary school students (6). An assessment was made, of whether a student's experience in the Pythonic Scratch platform would correlate with an increase in their problem-solving ability. Ultimately the study found that no such conclusion could be drawn, with no significant increase in problem-solving ability found amongst the participants. These findings further corroborate a web questionnaire that asks students to self-report their competence in various Computer Science topics (7). After performing the statistical analysis, it was found that those topics requiring an abstract understanding of computer memory and data structures e.g. pointers, copy constructors, and virtual functions, proved to be the most difficult for students. These studies suggest that particular care must be taken when designed a self-directed learning course, to either teach such topics directly or place particular focus on designing the learning resources robustly.

A final consideration worthy of note, is the rule of assessment in self-direct learning. This role, often performed by the instructor, is crucial to the suc- cessful development of a student's new skills. One course made use of a format dubbed the Personal Responsibility Orientation (8), which sought to measure the impact on student self-efficacy and self direction. This con- sisted of regular forums held each week amongst a group of peers, in addition to live coding exercises lead by students. As a further practical benefit in the area of assessment, Computer Science courses lend themselves well to the potential of automated assessment, in a step above instructor-led or student-led assessment. The CourseMarker CBA system marks Computer Science submissions automatically, when submitted in the form of solutions to mini programming exercises (9). The benefit to the student, includes the ability to receive near instantaneous feedback on submissions, with instruc- tors having the ability to self-select and tweak exercises to the appropriate challenge level.

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Dr Thomas Pearson

Can Metacognitive Skills Improve Student Exam Performance and Reduce Test Anxiety?

I compared the results of the students from the studied school on extended response questions to the national average. I drew data from AQA biology paper 1 and 2 from 2019. I used the biology papers due to the high number of questions that required prose in the answer compared to a higher amount of mathematical processing required in physics and chemistry.

The results demonstrated a 6% drop below the national average on extended response and focussed questions compared to a 4% drop on standard 1–4-mark questions.

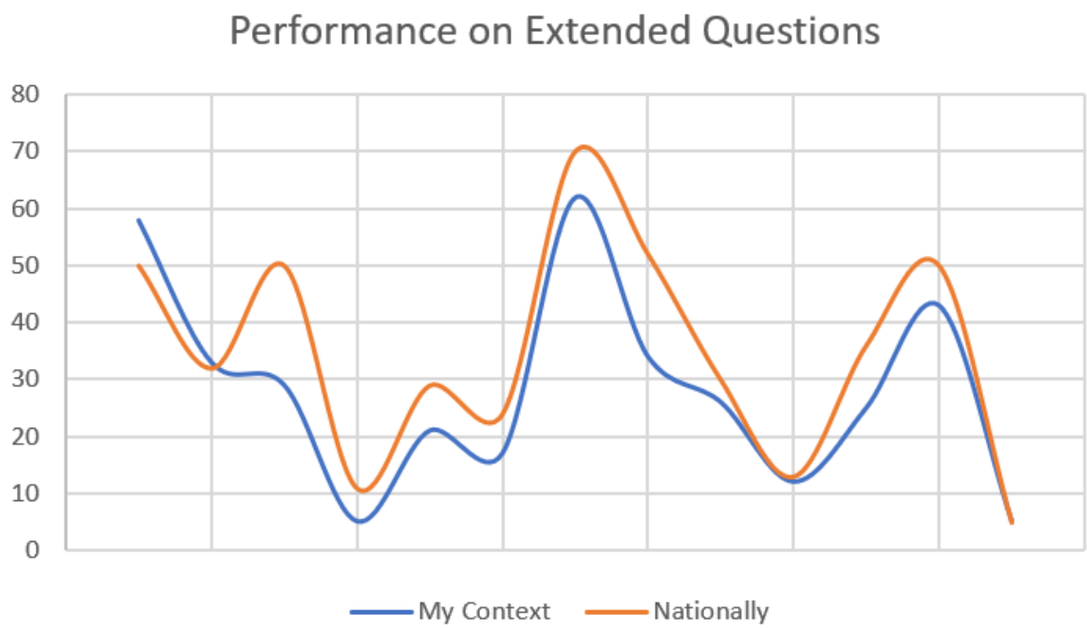

Figure 1

Student performance on extended exam questions compared to national average. Data obtained was obtained from the AQA for combined science. The Y-axis denotes percentage of marks, and the X-axis is an arbitrary question number.

I then polled different year 11 classes as they left mock exams to understand their thoughts and opinions on extended response questions. The word cloud highlights some of the most frequent expressions that the students used.

What is interesting here are the number of responses from students that mention the inherent difficulty of the question. This includes "too many lines", and "too much writing". That is either a sign that the style of the question is difficult for them, or that the student is not adequately motivated to provide an answer. Even if there is time left for the student at the end of the paper, they decide to put their head on their desk instead of attempting something difficult!

I believe one of the main obstacles to performing on extended response questions lies in test anxiety (Hembree, 1988). Anxiety is best understood as a negative emotional state without a specific object (Reber, 1995). Anxiety in exams is differentiated as being specific to a situation and context where students feel
under threat (Spielberger & Vagg, 1995). Several
distinct themes arise from analysing the root of this emotion (Denscombe, 2000).

Metacognition is a collection of skills and knowledge that bring about the feeling of knowing (Tarricone, 2011). Wolf, Brush and & Save (2003), acknowledges it as the knowledge of self, the task at hand,
and strategies to be employed". It is a highly important skill for effective pupil learning. Students with well-developed metacognition are aware of their strengths and weaknesses, can organise thoughts effectively and implement strategies to overcome difficult tasks (Labuhn, Zimmerman & Hasselhorn, 2010).

Students develop metacognitive skills as they mature, but many from disadvantaged backgrounds are less likely to develop these skills (Macleod, Sharp, Bernardinelli, Skipp & Higgins, 2015). A large proportion

of students from the studied school can be regarded as being from a disadvantaged background with 42.8% being classed as eligible for pupil premium. Veenman (2002), recognises that multiple types of test anxious students can exhibit poor metacognitive skills. Zeidner and Mathews' (2005) self-regulatory model explains that metacognition features as a central role in how a student responds to anxiety.

This project aims to teach students metacognitive skills and make metacognition explicit. Instead of simply utilising a scaffold to teach students to address tasks, I set out to enable students to create their own metacognitive cues to be used in exams.

The project utilised pre and post study questionnaires designed to analyse student awareness of metacognition, test anxiety and motivation to complete tasks. There was a baseline test with several extended response questions and then the same test at the end of the study. Their thoughts and feelings were also recorded in session diaries throughout the study.

The interventions consisted of me initially explaining the background material and introducing the idea of planning, monitoring and evaluation. I taught enough science content for students to then be able to engage with the planning task. An extended response question was then posed, and students were asked to design an answer plan in their diaries. The second and third interventions followed a similar structure, with the exception that students were taught metacognitive cues. These cues were discussed and refined as a group before students got the opportunity to further practice planning and answering extended response questions.
Four main questions emerged from studying the problem of student capability on extended response questions. When using metacognitive skills:

1. Can student attainment be improved?
2. Can students' motivation to tackle questions which they would usually avoid be increased?
3. Can students' anxiety be reduced?
4. Are students more focussed and documenting less task irrelevant responses?

The main two data collection sessions, the first and the fifth, had eleven

participants. They were given the same exam questions for both the baseline test and the concluding test. It was encouraging to see that the numbers of marks scored on the two tests did increase by an average of 26% across the sample group.

There were two notable exceptions of students who did not improve quantitatively. One of the two students wrote a plan and some thoughts in their diary; however, they did not have enough knowledge to score any marks on the extended response questions. In the case of the second student, they decided to spend the final session on their phone, before quickly writing a plan down in their diary and not adequately addressing the questions.

The post-study questionnaire demonstrates that four students now have exam techniques at their disposal, who previously answered that they did not. The questionnaire asks the participants to explain how they would answer a six-mark question, and the slide displays the four responses. The content of these responses is derived from the metacognitive cues featured in the intervention sessions. Phrases like "use previous questions to answer new ones", and "link things together in a conclusion", originated from discussing which cues were most helpful to the planning process.

Overall anxiety levels have dropped over the course of the interventions, although not a single student claims not to feel anxious at the prospect of an exam.

My goal is to disseminate my research within the Science department in the studied school. I expect that my findings are applicable to the Science department as a whole. The output of upcoming work will include the refining of the metacognitive cues, with an accompanying guide on best practice for use within lessons and mock exams to allow my colleagues easy access to the pedagogy.

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Dr Veronica Forcina

Does including career contents in Science lessons have a positive impact on students' career aspirations?

The benefits of a career provision in schools are numerous: from increased students' motivation and attainment (Irving, 2010) to decreased behaviour issues (Plasman, 2018).

The gap between the pupils' dream job and the path to follow to achieve that job was identified as the most important problem to tackle in the school I was working in, both by Career and Employability Coach and preliminary data collected by anonymous questionnaires of Year 8 students.

The urge to invest in the secondary students' career development that starts in schools has been highlighted in the past as a response to a huge change in the job market over the past generation both from the press (Hooley, 2013) and the Department for Education (DfE) (DfE, 2015). The importance of embedding career content in lessons has been shown to be one of the many ways schools could support students' career choices. The use of curriculum resources to effectively showcase career learning opportunities has been reported as advisable (Implementing the Gatsby benchmark). There is some evidence to suggest that experiences many years prior to student's making first career choices have an important influence on subsequent STEM subject and career choices (Tai, 2006). Conversely, students who took part in a six-week pilot STEM career intervention showed no significant change in their aspirations or views of Science (Archer, 2014).

Based on the school career literature, I decided to mainly focus on gaining a deeper understanding of whether having career talks during the Science lessons would increase the students' understanding of the steps and qualifications necessary to pursue a particular career and the information students have in order to make an informed choice after

GCSE.

Methodology

The expected outcomes of the career intervention project I carried out with 30 students in my Y8 Science class were:
increased awareness of future aspirations after GCSE, better understanding of the qualifications needed to achieve a particular job and increased perceptions from the students of the space given to career content in the lessons.

The project rationale was informed by preliminary data collected as answers to an anonymous multiple-choice questionnaire. It appeared clear that students had very little career's information and very little space in the Science lessons to talk about it. Prompted by this information the project aimed at changing a series of Science lessons to embed career content into them.

Moderating factors were also considered in planning the project. The career content needed to be added to the lessons by staying within the 50 minutes lesson time and without missing on any curriculum content. Moreover, the lessons were all structured in the same logical sequence and planned in advance in order to avoid negative effects on teachers' workload.

The study involved 30 students in Y8 in the school I am working in now. The students' sample was decided to be one class (30 students) that I already teach to make the project manageable in the time frame given to the researcher.

A series of four Science lessons (aerobic respiration, anaerobic respiration, structure of the lungs, asthma and smoking) from the topic respiration in the Year 8 curriculum were modified in order to include career content in them. The lessons were modified ensuring no curriculum content will be omitted from them. I delivered the edited lessons to 30 students in Y8 using my timetabled Science lessons.

The lessons were edited following a structure that includes: one example of Science career that is linked to the lessons' topic; a series of links to the introduced career throughout the lessons' tasks; a final slide that

summarises the qualifications needed for the job described during the lesson.

Students filled a five multiple choice anonymous questionnaire pre-intervention and post-intervention and the collected data were analysed and used to evaluate the impact of the intervention on the students involved.

Findings and next steps

The students' questionnaires revealed the pupils' overall increased awareness, even if not significant, of their future aspirations after GCSE.
The percentage of students who did not know what path to follow after GCSE slightly dropped after the career intervention (61% before the intervention versus 50% after the intervention.

The data also showed a slightly better understanding of the qualifications needed to aim at a particular job from the students after taking place in the career intervention project (10% difference before and after intervention). Project's limitations need to be considered when analysing the data and drawing conclusions from it. Firstly, the use of fixed-choice questions can be intrinsically bias and can be misleading (Hyman, 1955).
The small sample (30 students) selected for the career intervention might be a reason to overlook the outcome and potential benefit of the intervention (Schanzenbach, 2012).

The promising results obtained from the career project interested me and the Science Department to explore the scope of the project further in the future. Plans will be put in place to scale-up the career intervention to involve more year groups than Y8.

The Science Department is also planning to edit more lessons with embedded career content in order to cover a wider range of topics in the Science National Curriculum. The aim of the Science department is to create a series of career lessons resources that teachers can use at any

time when delivering topics during the academic year.

A series of lessons is going to be planned and delivered in order to embed an understanding of the different skills that pupils can acquire in the Science lessons and that can be useful for non-scientific careers.
Finally, it would be interesting to include non-scientific careers alongside with scientific ones in the lessons delivered to the students, in the attempt to widen their understanding on career's options and to give them the possibility to make a more informed decision about their future.

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