Written Assignment

EDU8223: Curriculum Development Through Enquiry in Practice

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To what extent do oracy strategies – including the explicit teaching of disciplinary vocabulary – affect pupils' confidence and ability to explain the problem-solving process when working with rational numbers?

Written Assignment

The Intent

Of particular interest to me is the intersection of written and spoken mathematical language. Time spent in the classroom has indicated to me that mathematics students generally struggle as much with the lexicon as they do with the underlying concepts. In the process, it seems that those who are more willing to engage with the language of a mathematician do so with aplomb. Muhaimin *et al.* (2024) suggest that both internal (self-efficacy) and external (teacher support) experience influence pupil mathematical literacy; I want to provide more students with access to and practice with disciplinary language as to further drive their confidence and attainment.

At my placement school, there was a recent departmental CPD spotlighting oracy and the desire to embed these techniques explicitly in the classroom. Emphasising spoken language in order to boost student confidence and foster a growth mindset (Dweck, 2006) aligns neatly with the empirical nature of the question we set out to discuss. Also, the viewpoint that "pupils learn from shared discussions with teachers *and* peers" (Black and William, 2010, p. 87) is a possible basis for the school-wide drive to include more verbal communication opportunities within lessons in order to deepen learning. My choice to focus on oracy thus addresses both of these similar intentions. The mathematics subject report by Ofsted (2023) notes that a "lack of language and comprehension" prevents students from deepening their understanding and developing problem-solving skills in general. Therefore, across my three lessons, I kept a glossary of key terms and definitions used which supplements the definitions and examples students have printed on the inside of their topic tracker (see Appendices A and B(iv)). Additionally, Mercer and Littleton (2007, p. 99), in their study of dialogue, suggest that "children also improved their attainment in mathematics… through their improved use of language". Although difficult to confidently quantify on a small scale, this also prompted my use of assessment data to gauge the effect of oracy and language teaching – see Figure 4. Of course, there are benefits and drawbacks to both of these, but this is discussed later. Note that while the literature overwhelmingly champions the role that oracy plays in fostering learning, it must be *structured*. Indeed, poorly scaffolded tasks risk distracting students from the demands of the subject itself, and increase cognitive load which prevents deeper understanding (Berg *et al.*, 2012). This seems to be echoed by the EEF guidance that "pupils may need to be taught *how* to engage in discussion" (Henderson *et al.*, 2022, p. 19). Note that this is based on the work of Kyriacou and Issitt (2008) who focus primarily on teacher-pupil dialogue, but it matters not (for us) whether the talk is developed in pupils for either the goal of dialogue with peers or with staff – the concern here is of mathematical discourse in general – and thus these sources remain valid for us.

The target class in question is a high-attaining Year 7 set. Although they generally operate at the upper echelon of ability, critical misconceptions occasionally reveal themselves. It is especially prudent to combat these swiftly given that the students' high school progression uses this year as its foundation. It is suggested that "giving explanations may help the explainer to reorganize [sic] and clarify… misconceptions… and acquire new strategies and knowledge" (Webb, 2008, p. 203). Furthermore, this class includes a number of EAL students (see Appendix C) who must also be given the opportunity to dialogue *academically*, not merely socially (Cummins, 2000). Running parallel to this are native speakers with a language deficit. Developing oracy skills could diminish the gap between students with different backgrounds. Watson (2013, p. 168) suggests that "middle-class pupils are at an advantage because the elaborated codes of language are what they might be used to at home" in comparison with working-class students. There will be a plethora of reasons as to why one student's literacy is more or less developed than another, and I have no accurate metric nor desire for gauging the 'class' in which my students reside, so this perspective is not taken in the present work. What we can garner, however, is that an insistence on using oracy techniques will certainly not hinder those that already understand the mathematics; this can help 'level the playing field', so to speak.

Within the lesson sequence (see Appendix A(i)), one of the primary strategies employed was the aforementioned glossary. My logic here is twofold: it first allows for students to continually familiarise themselves with the language of mathematics, and it further supports EAL pupils that typically struggle with reconciling English with mathematical vocabulary (Jourdain and Sharma, 2016). The topic of my lessons is not as rich with the Greek and Latin influences prolific in mathematics, but I nevertheless also provided word etymology given that it fosters the development of vocabulary and helps pupils talk disciplinarily (Rubenstein, 2000). These glossary addenda *may* allow students to infer meaning of disciplinary vocabulary from prior knowledge; identifying the root of a word "itself cannot provide a student with knowledge of [its] meaning", although they will be "better able to recognize [sic] a meaningful link to a related [already-]familiar word" (Bowers and Kirby, 2010, p. 531). Supplementing this is the use of sentence stems, so that the vocabulary can be practiced aloud. My observations and experiences suggest credence must be given to the classroom culture in which talk occurs, with regards to how successful it is. That said, research by Gaunt and Stott (2019, p. 66) accredits sentence stems as being the "simplest and most effective technique for scaffolding talk" because it expedites pupil engagement with the subject-specific language, especially for those who are lower-attaining or lacking in confidence. A case study by Quigley and Coleman (2021, p. 28) in their EEF guidance report validates this in the mathematical context.

Methodology

Student voice (see Figures 1 and 3) taken pre- and post-curriculum delivery was critical for qualitative evidence towards gauging the impression of students undergoing explicit oracy teaching. By offering up identical Likert-type scales with which the pupils had to express the level of agreement with a number of statements, this facilitates slightly more nuance than would be captured in binary responses (Likert, 1932). It would be remiss not to mention the strong likelihood of acquiescence bias, with "few respondents cho[osing] a particular category (e.g. *strongly disagree*)" when in doubt (Nemoto and Beglar, 2014, p. 6). One should consider this especially for the pre-sequence context, where the students are assumed inexperienced. Granted, prior knowledge in this class is strong but this was not assumed.

Dually, assessment data at the end of the lesson series offers quantitative data with which we can cross-reference the Likert-type ratings. By combining both qualitative and quantitative results, this provides a more thorough picture of the question at hand (Creswell and Plano, 2018). However, accurate comparison will be difficult: general trends (cf. Figures 1 and 3) suggest that oracy intervention and insistence on learning mathematical language have benefitted the students, but this conclusion is tentative due to the varied prior knowledge within the class. Nevertheless, a school residential the week of my sequence permits more accurate internal analysis; roughly one-third of the class were absent and were thus not affected by the explicit teaching of language and oracy, which although unfortunate educationally has prompted further comparisons to be made.

Participation in – and the work resulting from –this sequence of lessons has been completely anonymised; students are neither referenced explicitly nor indirectly by some discerning feature. Students were given the option to identify the work they submitted in order to facilitate more accurate conclusions based on their academic profile, but they were made aware that either they could remain anonymous or that any identifying traits would ultimately be redacted; this is in keeping with the Ethical Guidelines for Educational Research (BERA, 2024).

Implementation and Impact

A	I can explain how to add or subtract fractions using the correct language.
B	I feel confident saying words like “numerator”, “denominator”, “simplify” out loud.
C	I can explain my method to a partner.
D	I can explain my method to the class.
E	I feel confident writing explanations of how I solve problems.
F	Using the correct vocabulary helps me understand better.
G	I enjoy explaining my thinking out loud in maths lessons.
H	I feel more involved in lessons when working in pairs or groups.
I	I enjoy listening to how other people solve problems in maths.
J	I enjoy using mathematical vocabulary to describe my work.
K	I feel like I am part of the lesson when I talk about what I am doing.

Table 1

Table with labels for each question asked in both the pre- and post-sequence Likert-type questionnaires.

As has been discussed, the intention of my curriculum was to improve pupil oracy and build confidence with the subject dialect in mathematics. Starting with a pre-teaching questionnaire to gauge confidence, the expectation was the following: the students would be confident with the language of rational numbers to the level required in Year 7, but less so with reasoning and explanations using said language correctly. Indeed, 86% of students surveyed strongly agreed with statement **B** (see Table 1) regarding the use of tier three vocabulary, but this drops to 36% when having to *explain* a process using such language to a partner (see Figure 1, **B** and **C**). This could be due to disparity between receptive and productive language; students are more likely to comprehend disciplinary language than they are to use it (Nizonkiza, 2016). Although the focus of this work was on undergraduate students, its relevant mostly persists given the nature and complexity of mathematical language. Mercer and Sams (2006, p. 525) comment that “teachers’ encouragement of children’s use of… language leads to better… conceptual learning in maths”. The productive nature of this remark gives credence to the need for students to move from passive to active participants in the presence of subject-specific language.

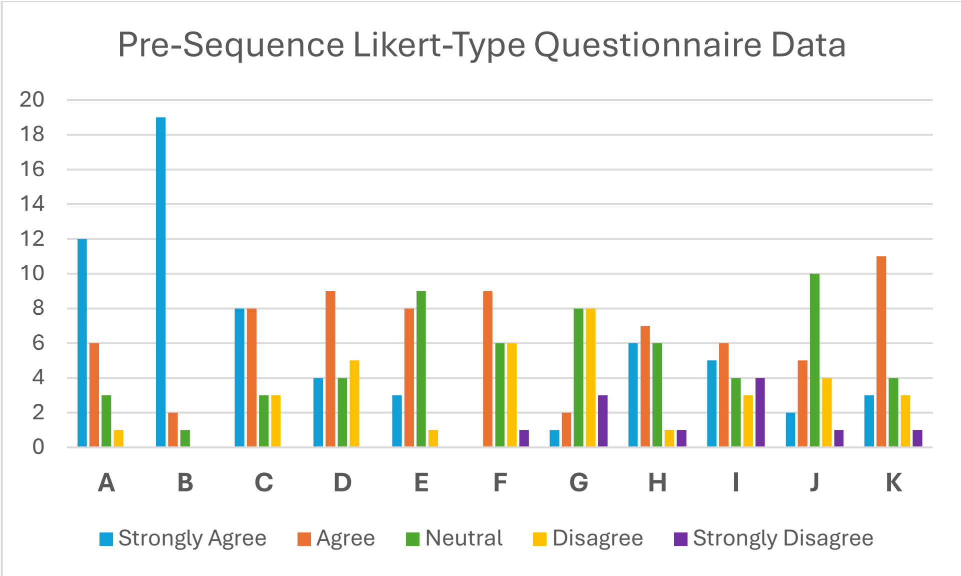


Figure 1
Responses to each of the eleven Likert-type questions posed *before* the start of the lesson sequence.

Building on this, only 18% of pupils felt strongly that they could explain their thought process to the *class*. When factoring in the agreed category, this improves to 59% yet still falls short of the 76% in comparison with the top two response tiers for explaining their thought process to their *partner*. One could suggest that students are more willing to participate in, and ultimately learn from, oracy tasks in smaller groups. Cooke and Adams (1998) suggest that talk tasks will foster mathematical development, in particular that small group discussions allow students to "develop a better understanding of the mathematics and more confidence in their own ability to solve difficult problems" (p. 39). This idea, in light of the data presented in Figure 1, prompted the inclusion of more think-pair-share and sage and scribe activities within the second and third lessons (see Appendix A), followed by more whole class-led discussion.

Within the first lesson, key terminology was introduced (most likely recapitulated for many of these students) immediately prior to a think-pair-share task where students use the language of fractions to describe equivalence; this is per the lesson plan in Appendix A(i). It is suggested there is a moderate relationship between understanding mathematical vocabulary and performance with higher-order problems (Lin *et al.*, 2021) in that it "does not simply serve as retrieved conceptual knowledge for mathematics problem-solving, but is also actively involved in mathematics comprehension and thinking" (p. 22). This is supported by Stevens *et al.* (2024) in the context of students with so-called *mathematical difficulties* (learning difficulties or consistent poor performance), who further comment that "vocabulary interventions were beneficial… when taught alongside relevant mathematical content" as opposed to in isolation; this is the main purpose of having a glossary. And in the context of my class, the fact that 73% of the class felt *strongly* (and 100% agreed that) the glossary assisted them when working with rational number problems (see Figure 3) gives further experimental evidence in support of the previous articles. However, earlier work by Peng and Lin (2019) suggests mathematical vocabulary is less useful for calculation. That said, my curriculum plan is designed so that it culminates with algebra problems, not just mere calculation, so their recent work remains valid. In future, an open-ended question would help explain pupil responses more fully. But given the positive reception to this oracy strategy, this should provide a foundation on which to build confidence and, eventually, mathematical understanding.

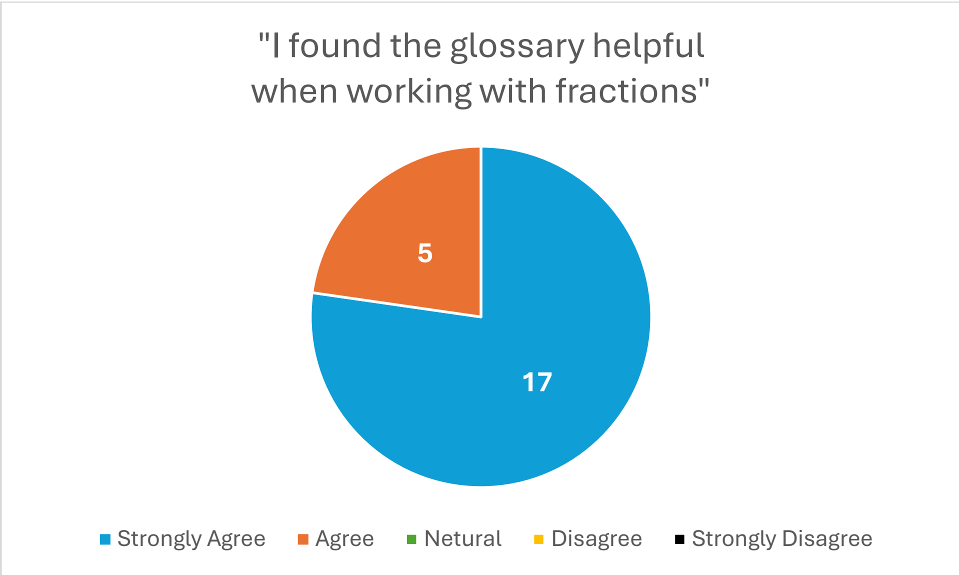


Figure 2
Pie chart representing student voice on the use of glossaries.

To begin the second lesson, the students were given a retrieval practice that involved writing the definition of a fraction, as recalled during lesson one. The benefits of testing memory in terms of retention are well understood (Roediger and Karpicke, 2006). When reviewing student responses on whiteboards, a majority of 91% – numbering 20 out of 22 students – referenced at least one of "denominator" and "numerator" on their boards, but only 18% used the word "integer". Upon probing, students were able to correctly use this word which might suggest a fault with the way this feedback was gathered; having students re-write something they produced on paper may invite a lack of *total* commitment given the repetitive nature of the demand. One student correctly recalled and used the word "quotient" that I taught them several lessons prior, which exemplifies how my insistence on introducing disciplinary language that isn't strictly needed for Year 7 is still having a positive effect on learning. This is also supported by questions asking for calculations *and explanations*; using this as formative assessment allowed me to track pupil attainment empirically.

The sentence stems activities were done in lesson two, wherein students were asked to order two rational numbers (one of them a sum of fractions, the other just a fraction) and explain their process to their partner aloud. Note that one of these was originally part of the first lesson plan (see Appendix A(i) and (ii)), but formative assessment necessitated an alteration. This type of problem is answerable by even younger students given that the instruction is sufficient (Behr *et al.*, 1984); the additional demand of verbalising an explanation is designed to increase the 14% of students that were happy to explain their thinking aloud (see Figure 1, **G**). We performed a second sentence stems activity – this time deciding a nearest integer to some rational number – in the third lesson, which concluded with the second questionnaire wherein pupil voice indicates a 63% approval for verbal explanations (see Figure 3, **G**). This suggests an increase in confidence, of particular importance for reluctant pupils (Gaunt and Stott, 2019). Because all students were talking with their partners at the same time, using this as an *accurate* metric may be misguided; I was only able to get an overview of the sentence stems usage. This instigated a cold calling approach to better probe and thus mitigate (albeit not completely circumvent) this issue.

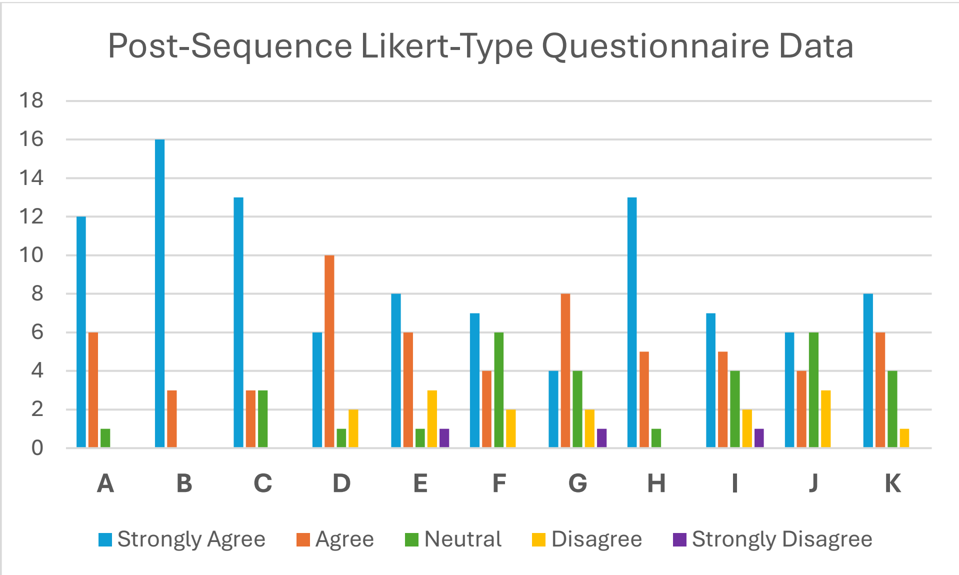


Figure 3
Responses to each of the eleven Likert-type questions posed *after* the start of the lesson sequence.

In the final lesson, the main task had students applying their knowledge of rational numbers to algebraic fractions. Although this did not test oracy and language explicitly, student explanations were focal given the transition from the tangible to the abstract. Lead-up activities involved paired talk, as a means of solidifying the confidence developed in the previous lessons. The students then worked through problems independently, allowing me to circulate and probe individually; I would ask them one-on-one to explain their thought process. Despite this not being quantitative, my assessment of pupil responses led me to conclude that they better understood how to work with rational numbers given their practice writing and verbalising explanations prior. In fact, "probing students about their errors in this study [on simplifying algebraic fractions] helped them to overcome their errors" (Makonye and Khanyile, p. 68); this sentiment is echoed by O'Halloran (2003), who suggests that oral language led by the teacher can aide students' understanding of mathematical expressions. Thus, not only has the emphasis on mathematical discourse allowed students to better understand rational number problem-solving, as we wanted to investigate, but the latter work suggests this bolsters pupils' grasp on the abstract. Perhaps this also results in improved confidence also, but sadly I did not offer a student survey specific to this final activity and thus this is conjecture alone. This is supported by the assessment data in Figure 4, showing averages from every test done under my supervision. Participants of this curriculum (Unit 10) performed 15.1% better on average than those that didn't; this is also 6.4% higher than the class average and the second highest average across any unit test this year. Of course, this may be due to a number of factors and the conclusion we make here is tentative at best. Note also that enjoyment at using mathematical vocabulary to describe pupils' work increased from 32% to 53% (see Figures 1 and 3, **J**). Hence, the mixed methods approach we have taken by combining this data with that from Figure 4 gives some credence to my hypothesis.

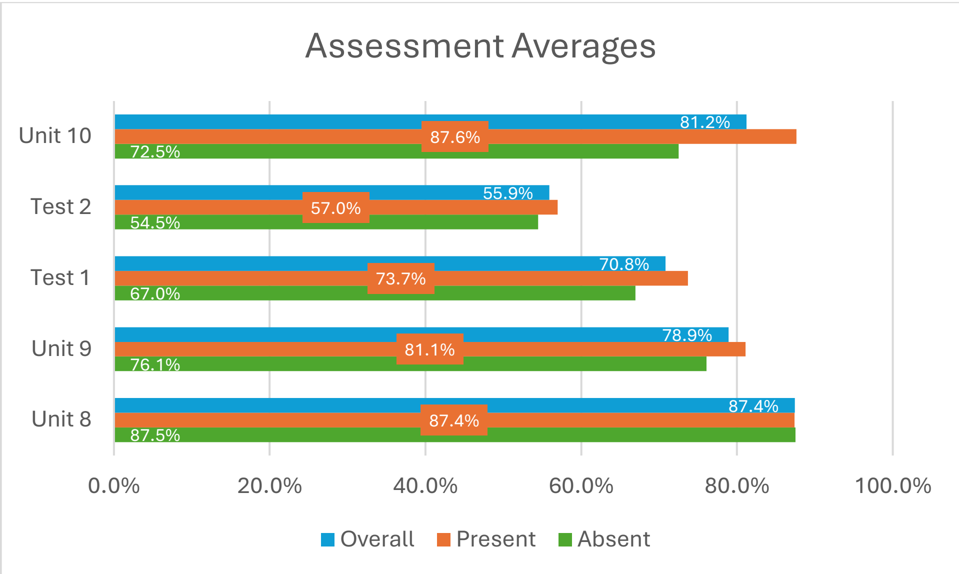


Figure 4
Student data from a test immediately after the content of the curriculum has been delivered.

As a postscript to the post-sequence questionnaire, students evaluated the impact that explicit vocabulary teaching and practice had on their metacognition. This relates to our question, because one can view confidence as a subset of metacognition (Efklides, 2006). We see in Figure 5 that 89% of pupils felt that the practice had a positive effect, with the remaining 11% having no strong feeling either way. Given that some students chose to waive their right to anonymity, these responses may be less genuine. On the other hand, there were relatively few (three out of 19 responses) that fall into this category, but even a shroud of obscurity may not be enough to prevent a 'please the teacher' attitude (Nemoto and Beglar, 2014); again, our conclusions have to be made cautiously.

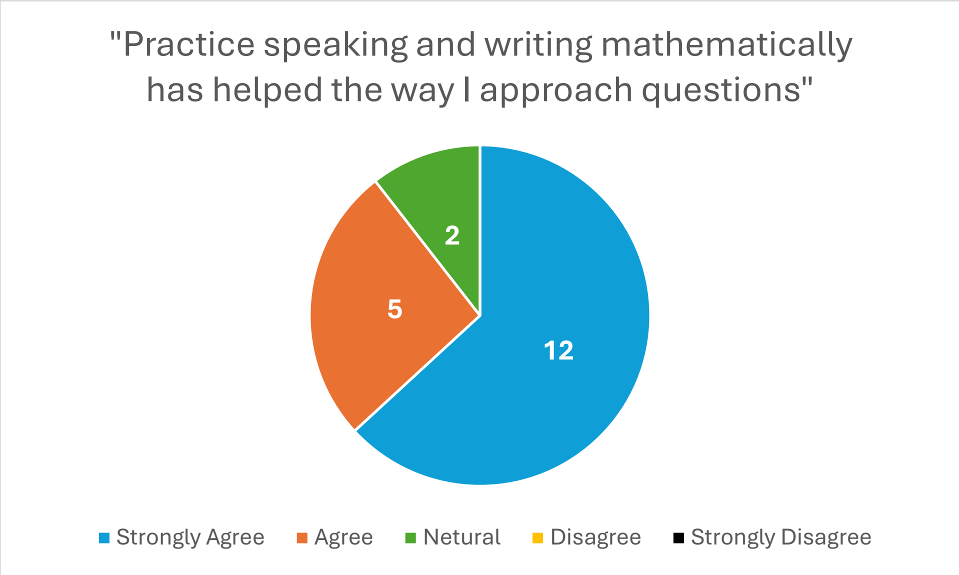
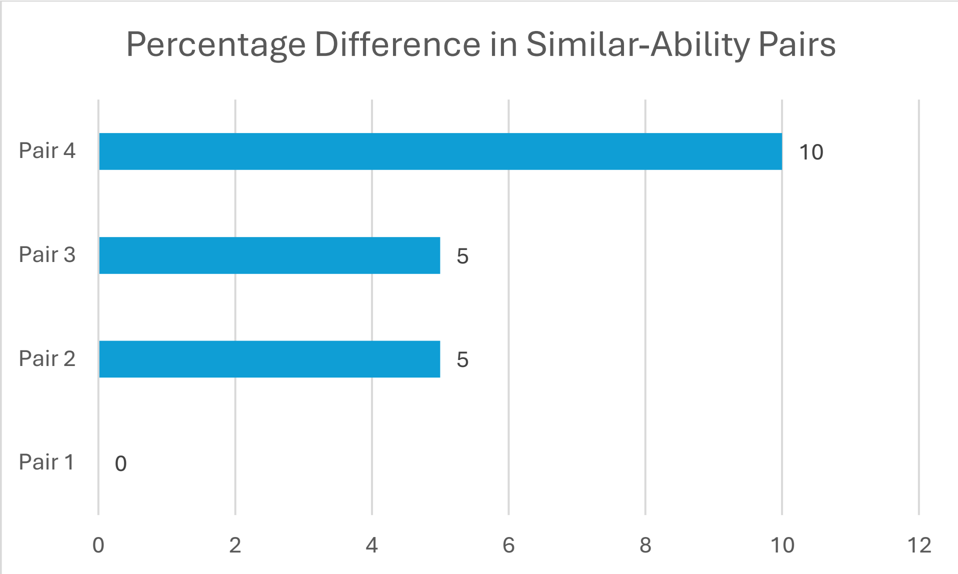


Figure 5
Results of survey asking students to evaluate the impact of oracy and language teaching.

Prior to the curriculum delivery, the seating plan was adapted from the norm. It was an approximate half-to-half split whether paired students were of similar ability or differing; the intention of this juxtaposition was to gain insight also on the implementation of oracy as a confidence booster in general versus where there is default shift in attainment paradigm. From my findings (see Figure 6), each category has a pair of equal disparity, but the average difference for the mixed-ability pairing is 4%, one percentage point lower than its counterpart. Given how close these figures are, and the rather small sample size it is garnered from, it is not possible to claim with certainty that one grouping is more successful than the other. In parallel, the discourse on which of the similar- and mixed-ability pairings facilitates learning most efficiently is found in the literature. Indeed, Kutnick *et al.* (2005, p. 368) claim that "same ability grouping may also inhibit classroom learning". As further supported by Webb (1989), it is difficult for lower-attaining pairs to reach a level of cognition required to deepen learning, and higher-attaining pairs can withhold knowledge from their peers. Despite this, such groupings would foster more equal dialogue amongst pairs given one individual is less likely to dominate the other (Webb, 1991); this is particularly beneficial for the testing of increased confidence due to explicit oracy. On the other hand, one could argue that the zone of proximal development as conceived by Vygotsky (1978) better stimulates learning for mixed-ability pairings, where the stronger student is able to implicitly scaffold the learning of the weaker student. Perhaps then the previously mentioned work of Webb (2008) suggests learning is happening for *both* participants, given the higher-attaining student is the so-called 'explainer' in this scenario. This dynamic does seem more tenuous because it risks a dominance-passive imbalance. It is precisely this dichotomy that informed my decision to investigate both avenues, sadly to little avail.



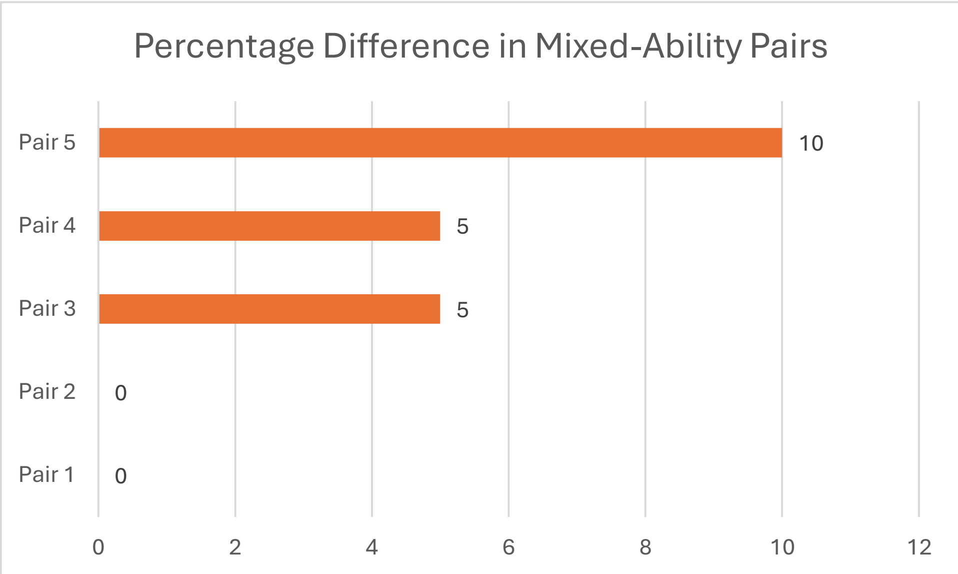


Figure 6
Difference in assessment results within each similar- and mixed-ability pairing.

Another curiosity, Figure 3 shows that one student strongly disagreed with statement **E** despite this not being the case in Figure 1. Although a single student, they account for 5% of those surveyed at that point. It is possible that confidence may have diminished due to the increased cognitive load upon introducing a lot more vocabulary and emphasising the importance of using disciplinary language *correctly*. Alternatively, this may be an embodiment of the Dunning-Kruger effect in the sense that the student initially inflated their self-efficacy, only learning this upon being confronted with explicit oracy tasks and language teaching. It is a shame more couldn't be done to analyse this since the student remained anonymous, but it is likely they felt comfortable revealing their reduction in confidence due to this very reason.

As per the AQA Mathematics specification (AQA, 2014), as subscribed to by my placement school, it is expected that pupils "accurately recall facts, terminology *and definitions*" (p. 38), with numerous references to vocabulary throughout the basic foundation content. This is further supported by the Ofsted subject report (2023); the plan for my sequence of lessons (see Appendix A) therefore had mathematical vocabulary and oracy at the forefront. However, fitting this module into the scheme of work proved difficult; I would have rather chosen a richer literacy-oriented topic, but this wasn't feasible. However, this restriction made me think deeply about how oracy can embed in areas that I wouldn't usually give such attentive focus; using the oracy skills from the curriculum's inception to inform the abstraction in the final lesson seemed like a neat way to exemplify a direct application of the literacy and its impact on understanding. Perhaps it would be interesting to compare the application of oracy across different topics with the intention of broadening the enquiry question and find an answer in totality.

During the delivery of the curriculum, it was unfortunate that it coincided with a separation of the class. This may diminish the credibility of our findings given the now-even-smaller sample size. That said, because comparisons with another similar class were not possible, this has inadvertently provided a means to determine the impact of oracy on academic achievement without reliance on other data with variables out of our control. But again, the data we work with is limited in scope. In future, this would be something I would trial across numerous classes, giving colleagues more advanced warning so that more data can be collected in as controlled a way as possible. Moreover, there were many opportunities within the lessons done to formatively assess students' oracy and understanding that have gone unrecognised. Indeed, the observing teacher was asked to make a tally of how often they heard students speak mathematically, but this never came to fruition. Fortunately, these still informed adaptations made to the lesson plans, most notably focusing more on definitions in the first lesson and talk in the second (see Appendix A(i)).

A vocabulary bullseye (see Appendix B(iii)) was used to bolster the sentence stems activity, wherein students work in-pairs, listening to their partner use words from their glossary. Although this does promote pupil-to-pupil dialogue, it is difficult for the teacher to extract meaningful conclusions due to the concurrent participation of every student in the class. Upon reflection, I believed it was not the most effective task for promoting confidence because, as a number of students did, they simply spoke the written words and the whole demonstration became superficial. This agrees with the suggestion that *gamified* tasks detriment pupil learning, despite the misconception that it will improve engagement and hence learning (Hanus and Fox, 2015). This led me to revise my plan for the third lesson, opting instead to focus more on how the language learning undertaken thus far influenced mathematical performance.

The enquiry found that oracy strategies, when paired with explicit vocabulary instruction, significantly improved pupils' confidence and moderately enhanced their ability to explain problem-solving processes with rational numbers. However, the size of the class suggests these findings are somewhat speculative, although this did provide us with a quasi-control group against which to compare assessment data. At the very least, our limited results advocate for further exploration of this question; this is something I will be cognisant of when moving forward in my own practice.

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Appendix A (Curriculum Overview)

(i) Lesson One Overview

By taking feedback through cold calling and mini-whiteboards, this allows me to determine the prerequisite knowledge the class has going into the curriculum, and ensure every student starts at the same place. This is very important as a sort-of control, to ensure that the enquiry is conducted cleanly and our conclusions are as accurate as possible.

Year 7 – Unit 10 – Addition and Subtraction of Fractions (M3 Lesson 1)

Big Picture

This is lesson 7 of 9 in the unit teaching about fraction representations, addition, subtraction, equivalence and algebraic fractions.

Intent / Objectives

Be able to understand and explain how to find equivalent fractions, using the correct language.

Practice adding and subtracting fractions whose denominators are multiples of each other, and writing/verbalising the method.

Links to Prior Learning/Misconceptions

Prior Learning: Representing fractions as pictures and how to add and subtract fractions when the denominators are the same.

Misconception: Adding the numerators when the denominators are different, or adding the denominators also.

Adaptations

Printed resources to reduce writing time and help students that may be near-sighted.

Checking for Understanding / AfL

Mini-whiteboard activities.

"We Do" with cold calling.

Teacher circulates during independent work, especially important during talk tasks.

Literacy / Oracy

Teacher using technical language: denominator, numerator, equivalent, common multiple.

Oracy: Students to dialogue in pairs before whole class discussion. Provide sentence stems for students to practice explaining their justifications and thought processes. Use of a glossary to direct talk.

Next Lesson Recall Points

The method of adding and subtracting fractions whose denominators are multiples, to pave the way to doing this with arbitrary denominators.

The language used, including the definition of a fraction recalled again this lesson (and hence also the next).

Models/Analogies/Links

Use bar models to motivate adding fractions, or pictures of circles split into sectors. This may be especially useful to tackle the misconception of also adding the denominators when operating with fractions.

Admin / Logistics / H&S

Mini-whiteboards.

Students sat in pairs.

Learning Episode / Activity 1

Retrieval Practice: The retrieval here will involve adding and subtracting fractions where the denominators are already equal; this will ensure students are comfortable with the process. It will also involve simplifying a fraction, to recap pupils on what it means for two fractions to represent the same number. Additionally, some basic algebra questions will be included to start students thinking and working more abstractly, in view of M3 lesson 3.

Learning Episode / Activity 2

Glossary: Students to build a glossary of terms to use in their verbal and written explanations, with the guidance of the teacher to ensure that definitions are written correctly. Where appropriate, the etymology of words (e.g. fraction from *frangere* and *fractio* – to break) also provided. This can then be used to encourage students to write down their process when adding and subtracting fractions whose denominators are multiples of each other.

Learning Episode / Activity 3

Sentence Stems: Students will answer two questions, testing their knowledge of adding and subtracting fractions but in the context of ordering and rounding the end results. In pairs, they will take it in turns to use the provided sentence stems, and their glossaries, to explain their reasoning. Partners will be expected to tick off the key words they hear from who they are paired with.

Overview 1

Ensuring that all students have a partner is imperative to the aims of the enquiry. One of the main oracy tasks this lesson is the sentence stems activity, which requires pupil-to-pupil interaction.

By anticipating pupil misconceptions, this allows me to pre-prepare alternate models in order to ensure that the focus of the curriculum is solely the oracy and literacy. I want to mitigate external barriers, and probe any misunderstands with mathematical *language*.

As a foundation for the sequence of lessons, we start by forming a glossary of key terms: denominator, numerator, common multiple, common factor, equivalence, integer. These are added to as the sequence progresses (next lesson will also involve mixed numbers and improper fractions). These will provide a scaffold for students during the sentence stems task; starting a sentence is only as good as knowing what its contents mean.

I originally planned the sentence stems activity for the first lesson, but upon realising that some pupils were not totally confident with the language I was demanding, it was better to dedicate more of that first lesson to examples and non-examples when working with rational numbers. Accordingly, I changed the plan for the second lesson, moving the vocabulary bullseye into the third lesson in lieu of more paired work to build confidence.

(ii) Lesson Two Overview

Year 7 – Unit 10 – Addition and Subtraction of Fractions (M3 Lesson 2)

Big Picture

This is lesson 8 of 9 in the unit teaching about fraction representations, addition, subtraction, equivalence and algebraic fractions.

Intent / Objectives

Be able to add and subtract *arbitrary* fractions.

Practice solving higher order problems involving these operations, and explaining the methods used.

Links to Prior Learning/Misconceptions

Prior Learning: Adding and subtracting fractions whose denominators are multiples of each other

Misconception: Making incorrect comparisons with fractions, e.g. claiming that $3 < 5$ implies $\frac{1}{3} < \frac{1}{5}$ or the like.

Adaptations

Printed resources to reduce writing time and help students that may be near-sighted.

Refer students with EAL and PP to the glossary to help them keep focus on the language used and reduce cognitive load.

Checking for Understanding / AfL

Mini-whiteboard activities.

"We Do" with cold calling.

Teacher circulates during independent work, especially important during talk tasks. They will also probe pairs about the vocabulary bullseye exchange to better gauge its impact.

Literacy / Oracy

Teacher using technical language: denominator, numerator, equivalent, common multiple.

Oracy: Students to dialogue in pairs before whole class discussion. Provide sentence stems for students to practice explaining their justifications and thought processes. Use of a glossary to direct talk.

Next Lesson Recall Points

The method of adding and subtracting arbitrary fractions.

Methods that can be used to determine the size/order of two fractions.

The language used, especially the new words added to the glossary (mixed number and improper fraction).

Models/Analogies/Links

Again, students can be offered bar models to consider the addition of fractions, especially when working with mixed numbers and improper fractions (to better understand how many wholes there are).

Admin / Logistics / H&S

Mini-whiteboards.

Students sat in pairs.

Learning Episode / Activity 1

__Retrieval Practice__: As part of the retrieval, students are asked two fraction arithmetic questions – this consolidates the learning from the previous lesson – as well as an algebra question, to prepare for the final lesson. Most critically, they will be asked to define a fraction using correct mathematical language.

Learning Episode / Activity 2

__Sentence Stems__: This has been moved from M3 Lesson 1, given the unease students initially had at explaining their process to the teacher and their peers earlier in the curriculum. An extension has now been added, including fractions with non-multiple denominators given that this is one of the intentions of this lesson.

Learning Episode /Activity 3

__Vocabulary Bullseye__: Students will take it in turns to speak with their partner and tally up the total amount of points they accrue. The teacher will expect students to write (at least) one good phrase they hear from their partner, and expect to be asked to recite this to the class.

Having made the glossary in M3 Lesson 1, it is now possible to add more words and definitions; in hindsight, this would have been good to combine into a Frayer model, but nevertheless it can still be used for all students. In particular, it can help remove extraneous barriers.

Practicing explicit definitions is a means of getting students to think and use the language of mathematics, which should boost their confidence. This was done as both a written and a whiteboard activity, with boards chosen to exemplify good definitions and promote class discussion.

Overview 2

In order to improve student confidence with speaking mathematically, I decided to include this activity. As discussed above, the gamification of using the disciplinary vocabulary may have rendered the activity moot; this meant I increased focus on the mathematics in M3 Lesson 3 and how oracy can influence the knowledge rather than a direct practice of talk. This was introduced by demonstrating a non-mathematical example.

(iii) Lesson Three Overview

Think-pair-share has been focused this lesson to undo the gamification of the vocabulary bullseye and better focus on the conceptual understanding of adding and subtracting fractions. As an extension, I posed to some students how they could *prove* the method for converting a mixed number into an improper fraction.

In each of these activities, students were asked to write down their process, explaining each step towards answering algebra questions. In particular for Activity 2, I circulated and asked students to verbalise their thought process and methods. This allowed me to probe both their grasp of using the subject nomenclature and their confidence with not only the language but the mathematical meaning behind it.

Year 7 – Unit 10 – Addition and Subtraction of Fractions (M3 Lesson 3)

Big Picture

This is lesson 9 of 9 in the unit teaching about fraction representations, addition, subtraction, equivalence and algebraic fractions.

Intent / Objectives

Apply the knowledge of adding and subtracting fractions to an algebra context.

Complete the topic assessment.

Links to Prior Learning/Misconceptions

Prior Learning: Adding and subtracting fractions, including mixed numbers.

Misconception: Misidentifying common multiples when finding algebraic common denominators, and likewise common factors when simplifying an algebraic fraction.

Adaptations

Printed resources to reduce writing time and help students that may be near-sighted.

Refer students with EAL and PP to the glossary to help them keep focus on the language used and reduce cognitive load.

Checking for Understanding / AfL

Mini-whiteboard activities.

"We Do" with cold calling.

Teacher circulates during independent work, encouraging paired discussions when doing the algebraic fractions questions with correct language use.

Literacy / Oracy

Teacher using technical language: denominator, numerator, common multiple, expression, term, linear.

Oracy: Students to dialogue in pairs before whole class discussion. Provide sentence stems for students to practice explaining their justifications and thought processes. Use of a glossary to direct talk.

Next Lesson Recall Points

Retrieval practice including some of the language used in this unit.

Standard form (the next topic) involves decimals, so practice conversions into fractions and explanations using the correct vocabulary.

Models/Analogies/Links

Bar models can be used to explain solving algebraic equations.

Pictures representing different like terms can solidify the fact that different powers (x^2, x^3 etc.) are not like, e.g. using an image of a square or a cube to represent these algebraic objects.

Admin / Logistics / H&S

Mini-whiteboards.

Students sat in pairs.

Learning Episode / Activity 1

__Algebra Practice__: One of the first activities is to review basic algebra, including expanding brackets, collecting like terms and basic factorisation. These ideas will be embedded with fractions in increasing complexity.

Learning Episode / Activity 2

__Algebraic Fractions__: Students will be expected to add and subtract a number of algebraic fractions, beginning with those that have the same denominator (algebraic or otherwise) and ultimately leading to ones where a common denominator must be found. As an extension, some questions will involve solving an equation where one side is the sum of algebraic fractions.

Learning Episode /Activity 3

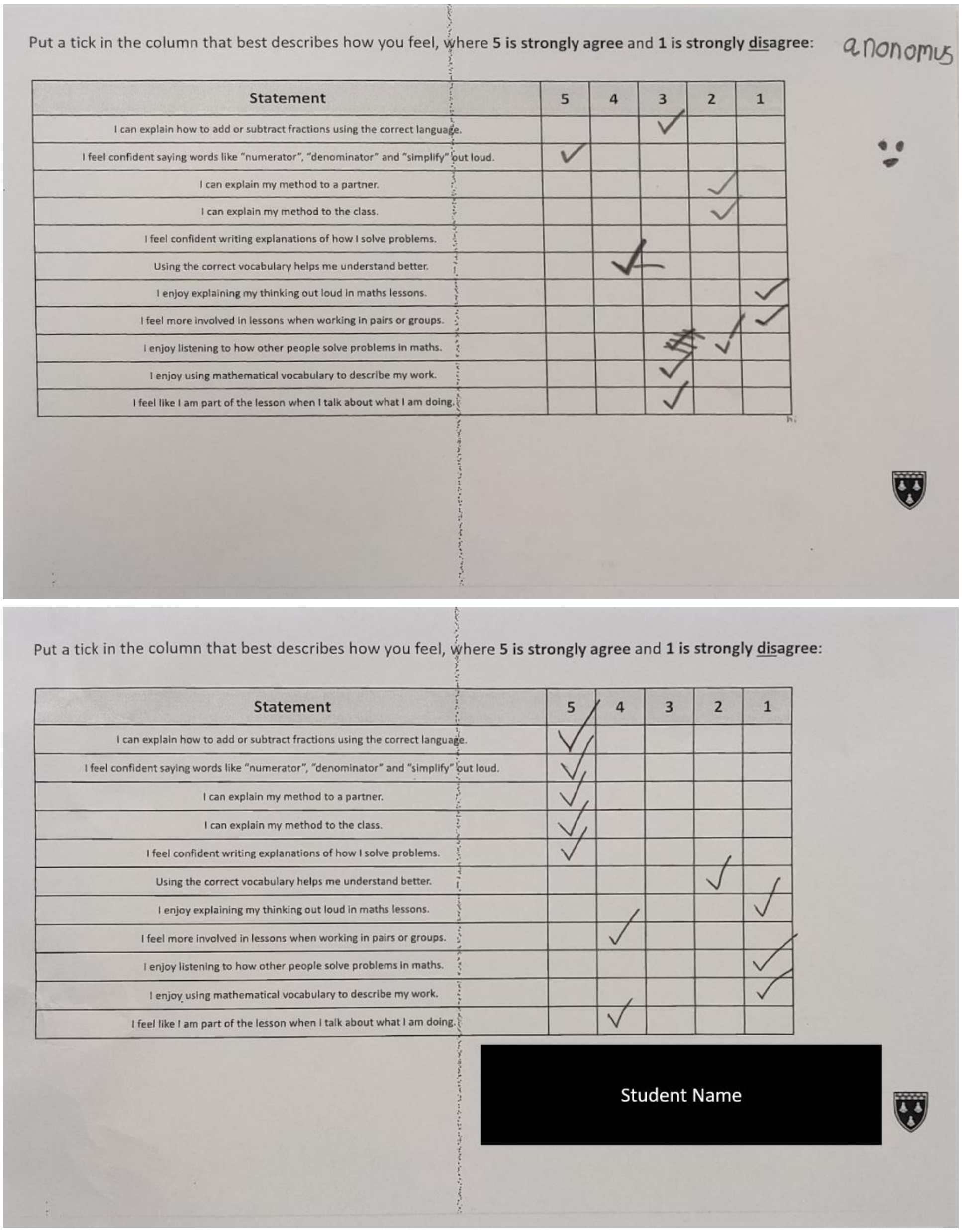
__Assessment__: The students will complete the topic test for this unit (any absent students will do so the first lesson they return). These are short assessments, so will only take at most 15 minutes.

Overview 3

This is a crucial opportunity for summative assessment that indicates how the class is adapting to the oracy learning and applying it to conceptual questions. This helps answer the final part of the enquiry on explanations (in this case, written). This has been graded and compared against the tests done by this class' students that were away during the week of the curriculum delivery.

Appendix B (Student Work)

(i) Pre-Curriculum Confidence Ratings



Put a tick in the column that best describes how you feel, where **5 is strongly agree** and **1 is strongly disagree**:

anonomus

Statement	5	4	3	2	1
I can explain how to add or subtract fractions using the correct language.			✓		
I feel confident saying words like "numerator", "denominator" and "simplify" out loud.	✓				
I can explain my method to a partner.				✓	
I can explain my method to the class.				✓	
I feel confident writing explanations of how I solve problems.					
Using the correct vocabulary helps me understand better.		✓			
I enjoy explaining my thinking out loud in maths lessons.					✓
I feel more involved in lessons when working in pairs or groups.					✓
I enjoy listening to how other people solve problems in maths.			~~✓~~	✓	
I enjoy using mathematical vocabulary to describe my work.			✓		
I feel like I am part of the lesson when I talk about what I am doing.			✓		

Put a tick in the column that best describes how you feel, where **5 is strongly agree** and **1 is strongly disagree**:

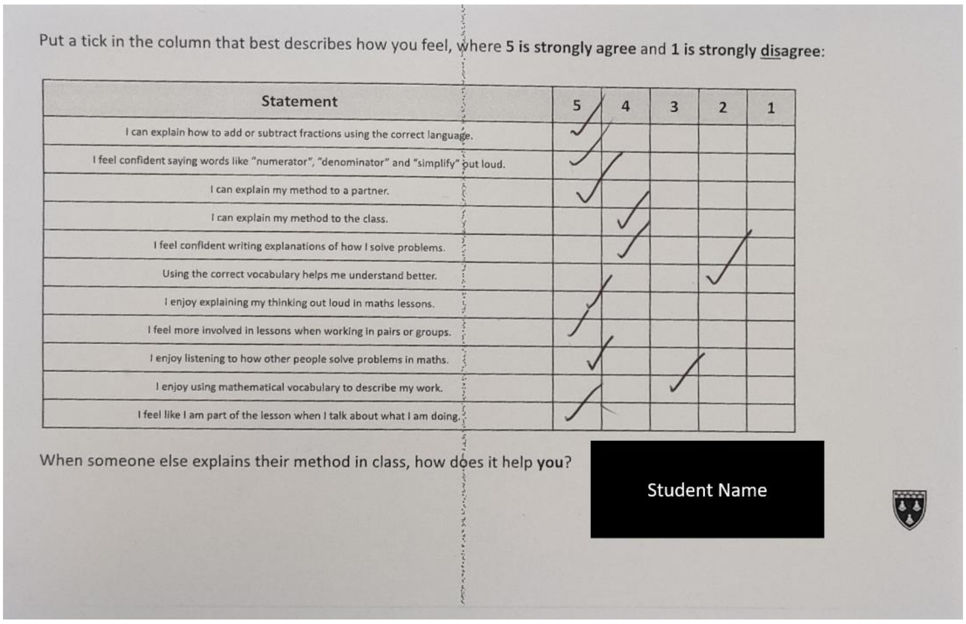
Statement	5	4	3	2	1
I can explain how to add or subtract fractions using the correct language.	✓				
I feel confident saying words like "numerator", "denominator" and "simplify" out loud.	✓				
I can explain my method to a partner.	✓				
I can explain my method to the class.	✓				
I feel confident writing explanations of how I solve problems.	✓				
Using the correct vocabulary helps me understand better.				✓	
I enjoy explaining my thinking out loud in maths lessons.					✓
I feel more involved in lessons when working in pairs or groups.		✓			
I enjoy listening to how other people solve problems in maths.					✓
I enjoy using mathematical vocabulary to describe my work.					✓
I feel like I am part of the lesson when I talk about what I am doing.		✓			

Student Name

Work 1
Completed pre-sequence Likert-type questionnaires.

The extracts presented in Work 1 demonstrate an anonymised and an overt response to the initial questionnaire. It seems reasonable to suggest that the first of the two answers is honest given the student has elected to remain anonymous. Curiously, however, the second response is almost as candid. The student, who will remain anonymous given the Ethical Guidelines for Educational Research (BERA, 2024), is high-attaining. Their response suggests they are confident with the vocabulary and concept yet prefer working independently. A number of responses echoed this one.

(ii) Post-Curriculum Confidence Ratings

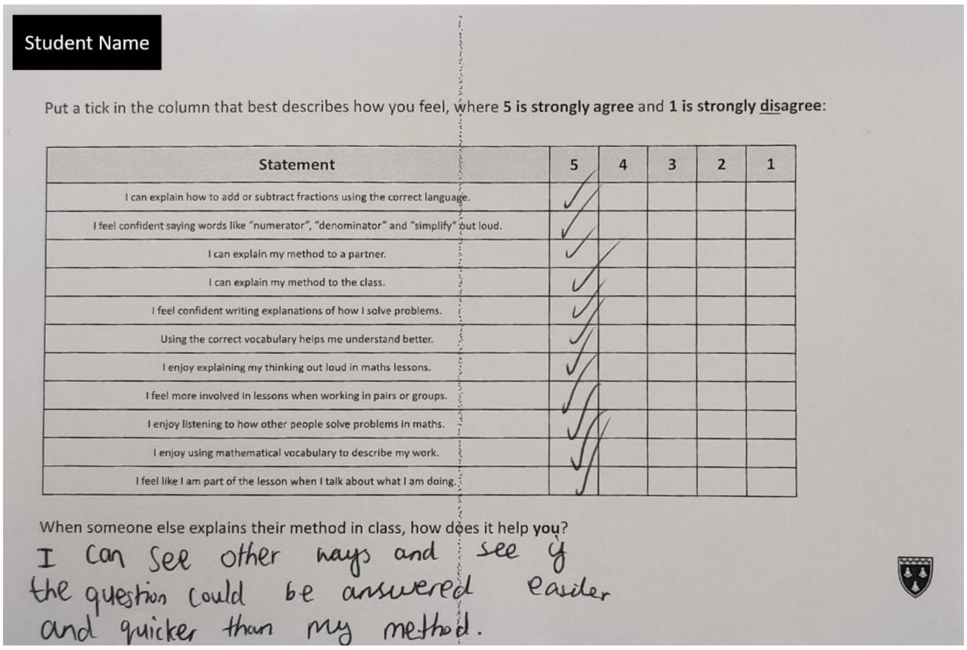


Put a tick in the column that best describes how you feel, where **5 is strongly agree** and **1 is strongly disagree**:

Statement	5	4	3	2	1
I can explain how to add or subtract fractions using the correct language.	✓				
I feel confident saying words like "numerator", "denominator" and "simplify" out loud.	✓				
I can explain my method to a partner.	✓				
I can explain my method to the class.		✓			
I feel confident writing explanations of how I solve problems.		✓			
Using the correct vocabulary helps me understand better.				✓	
I enjoy explaining my thinking out loud in maths lessons.	✓				
I feel more involved in lessons when working in pairs or groups.	✓				
I enjoy listening to how other people solve problems in maths.	✓				
I enjoy using mathematical vocabulary to describe my work.			✓		
I feel like I am part of the lesson when I talk about what I am doing.	✓				

When someone else explains their method in class, how does it help **you**?

Student Name



Student Name

Put a tick in the column that best describes how you feel, where **5 is strongly agree** and **1 is strongly disagree**:

Statement	5	4	3	2	1
I can explain how to add or subtract fractions using the correct language.	✓				
I feel confident saying words like "numerator", "denominator" and "simplify" out loud.	✓				
I can explain my method to a partner.	✓				
I can explain my method to the class.	✓				
I feel confident writing explanations of how I solve problems.	✓				
Using the correct vocabulary helps me understand better.	✓				
I enjoy explaining my thinking out loud in maths lessons.	✓				
I feel more involved in lessons when working in pairs or groups.	✓				
I enjoy listening to how other people solve problems in maths.	✓				
I enjoy using mathematical vocabulary to describe my work.	✓				
I feel like I am part of the lesson when I talk about what I am doing.	✓				

When someone else explains their method in class, how does it help **you**?

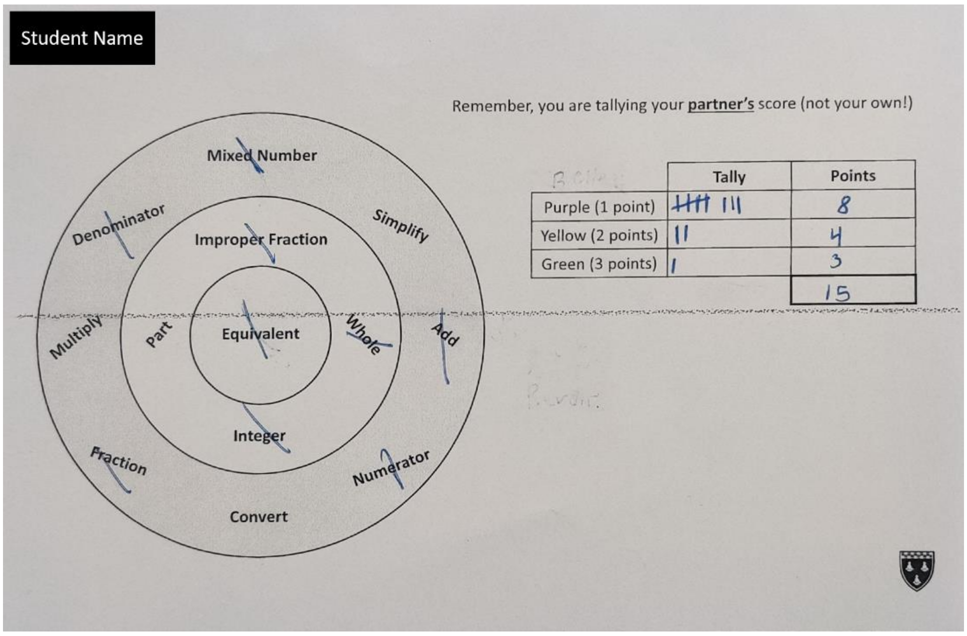
I can see other ways and see if the question could be answered easier and quicker than my method.

Work 2

Completed post-sequence Likert-type questionnaires.

The responses in Work 2 are somewhat telling. The initial one seems rather candid given that the student waived their right to anonymity – it seems that the Year 7 class as a whole were rather honest in their ratings, at least to the best of their knowledge. However, the second hand-in suggests a classic case of wanting to please the teacher. That said, they were the only student to answer the written open-ended metacognitive question. This may be a result of their want to satisfy the demands of the educator, but at least it offers deeper insight into the impact on confidence and understanding.

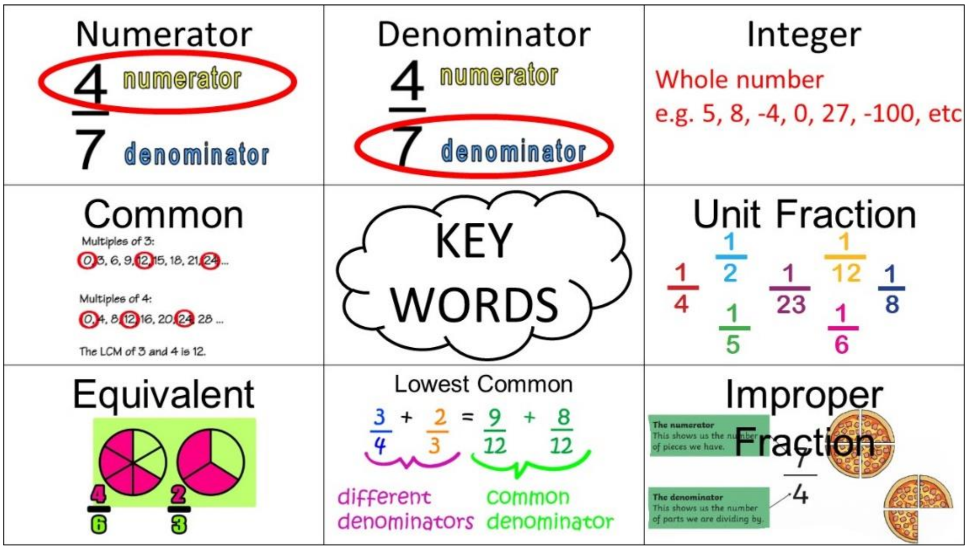
(iii) Vocabulary Bullseye



Work 3
Example of the vocabulary bullseye in faction.

As we have discussed, the vocabulary bullseye was a good way to get students talking, but its relevance and affect are somewhat in question; students were overheard simply reading off the terminology without an attempt at continuous prose or anything more than surface-level understanding. The example in Work 3 is one that suggests some students adhered to the instruction, given that the participant did not cross off every word. The *vast* majority of submissions were completed to all 19 points. Perhaps it is cynical to assume the students may not have performed as intended, but I think this the more realistic likelihood.

(iv) Terminology List



Work 4

Terminology list inside the unit topic tracker, a departmental resource, stuck in the students' exercise books.

The department at the placement school hand the students a topic tracker at the start of each unit, attached to which is a vocabulary sheet. This is helpful, especially due to the dual coding, but its major limitation is the lack of an actual definition. This necessitated the introduction of a glossary in my curriculum, which will act in parallel with the above resource the pupils already have.

Appendix C (Class Data)

Figure 7

Coloured seating plan – red (absent), blue pair (similar-ability) and purple pair (mixed-ability) – with test percentages.

There are three EAL students in the target class, and three PP students (only one of which was present due to the aforementioned residential trip). From our results, it appears that the EAL students performed equally as well in their assessments as their first-language partners. Note that their average was 92%, which is much higher than the 81% mean percentage of the class.

Furthermore, the seating plan was slightly adapted from the norm given the number of absent students, as to ensure all students had a working partner; there was an exception in that sometimes a group would work as a three or I would pair with one of the students, on rotation. The major disadvantage to this is that the student-teacher dynamic may bias the discussion; the student may be more nervous in comparison to working with a peer. That said, during the course of the curriculum delivery, even this subset of the class would diminish further due to illness, music lessons and the like. This often meant that students would have a peer as a partner, but sadly this means that our results cannot be interpreted as fully as I would wish.