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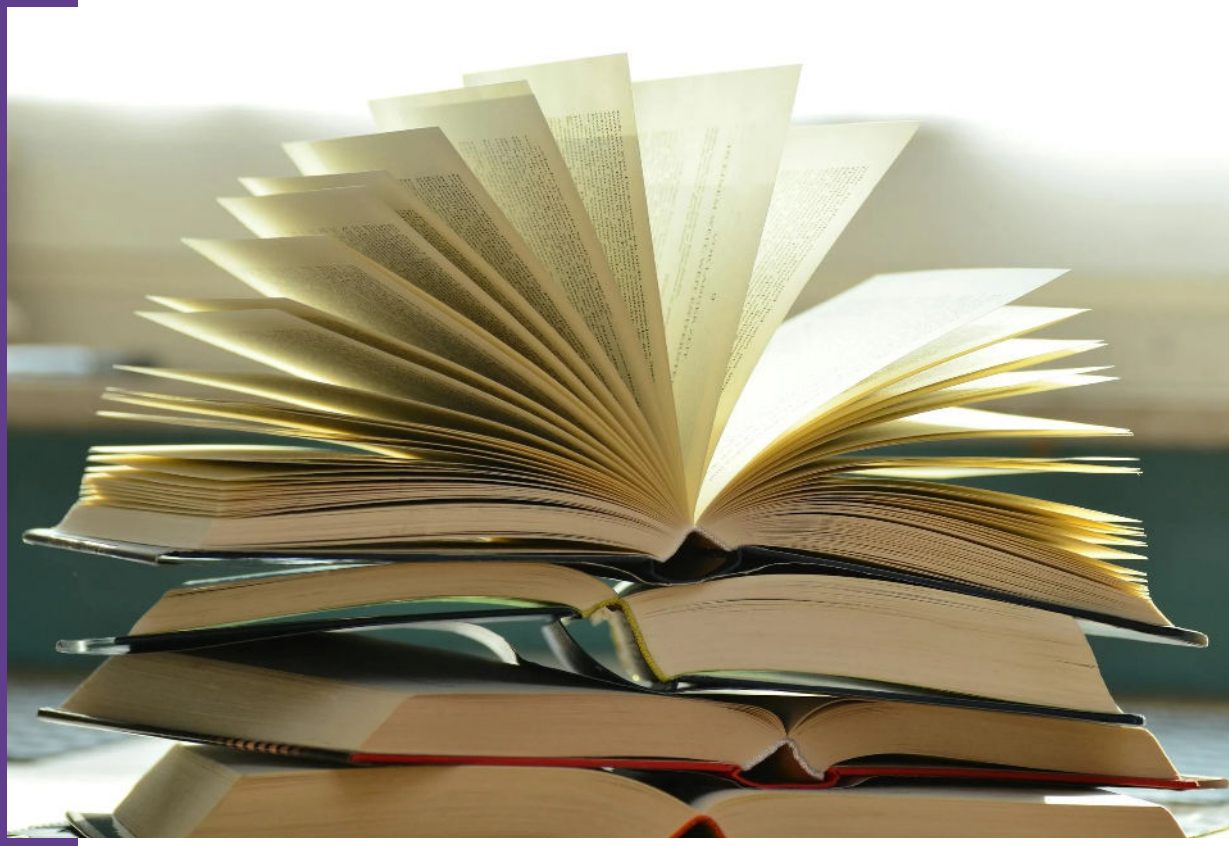
PerseResearch

Disciplinary Literacy



The Perse Journal

Edited by Hazel Knight

THE PERSE SCHOOL CAMBRIDGE

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FOREWORD

Intellectual curiosity and scholarship sit at the heart of The Perse. Here, pupils and teachers alike think, reflect, research, debate and discuss—seeking deeper understanding of both subject matter and how we teach and learn.

To work at The Perse is to belong to a vibrant community of subject and pedagogical experts, energised by pupils with a palpable thirst for learning. A shared readiness to "go the extra mile" creates a virtuous circle in which conscientious teachers and determined pupils raise one another's game. This is a school where teachers and pupils want to be their best, and research is fundamental to this pursuit of excellence.

We take research—by staff and pupils—seriously. Research strengthens knowledge, understanding and skills. The opportunity to research areas of personal interest can be really rewarding and significantly motivational, powering staff and pupils on to further learnings that will benefit themselves and others.

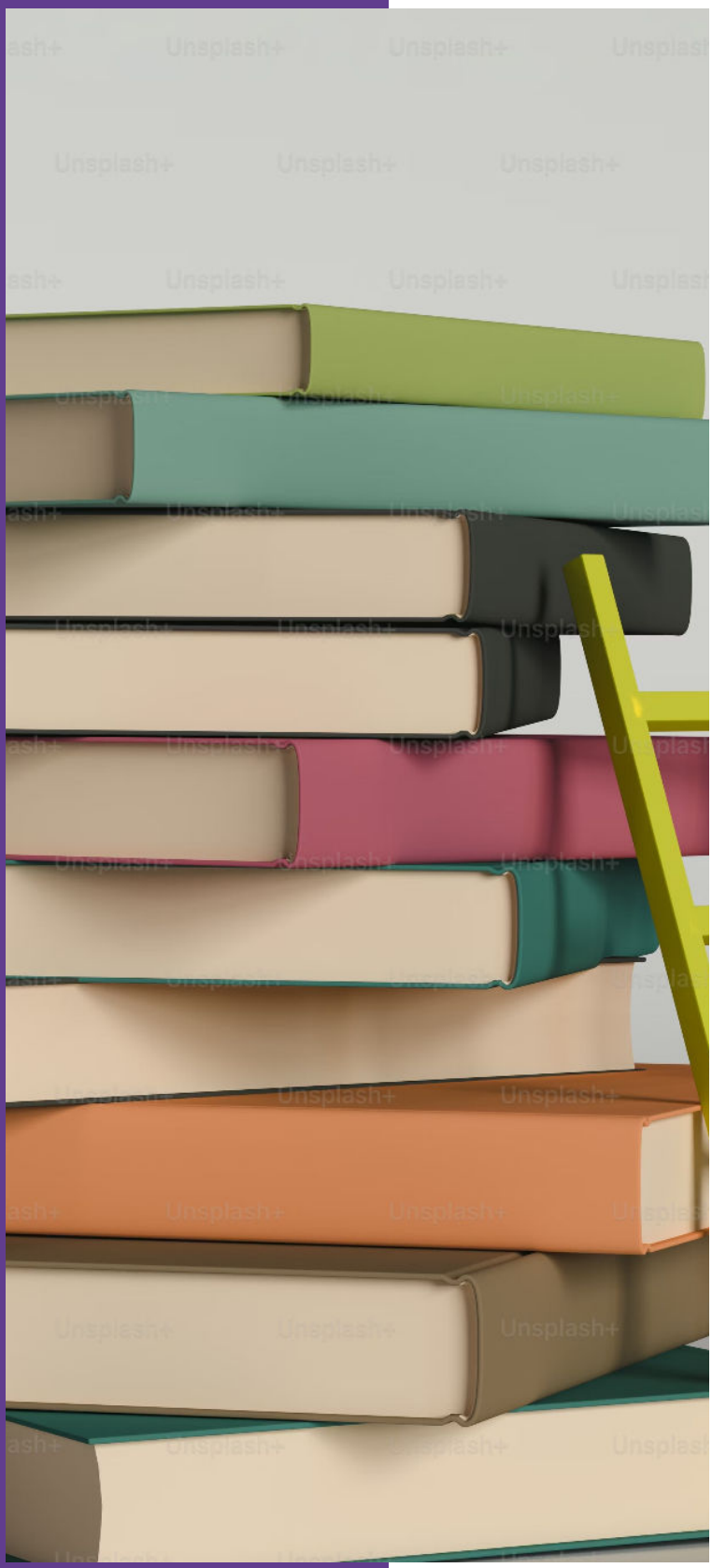
Perse Research offers a window into the professionalism, inquiry and dedication of colleagues engaged in focused studies to improve teaching and learning.

My thanks to Hazel Knight, Paige Boxhall, Donald MacLennan, Sarah Mitchell and Eleni Pepona for sharing their work in this journal—research that is already prompting me to refine my own practice.

Sincerely,

Ed Elliott
Head

03



A review of the literature

Hazel Knight
Head of Research

In the Educational Endowment Foundation's (EEF) report on 'Improving Literacy in Secondary Schools', the top recommendation was to prioritise disciplinary literacy (*Improving Literacy in Secondary Schools*, 2021). Disciplinary literacy is the idea that reading skills, rather than being generic, are specific to each subject domain; disciplinary literacy is "how to read, write and communicate within specific subject disciplines" (EEF, 2023). For example, literacy in Science involves the use of a great deal of specialist terms which are often the noun form of processes (e.g. evaporation, sublimation), whereas literacy in History requires the understanding of the use of metaphor (e.g. dissolution, revolution) and significant use of inference. Literacy in Geography requires reading maps as well as text, and literacy in Maths involves the ability switch between representations, languages and formats within just a few lines of text. Authorship matters more to the historian or literary critic than to the scientist or mathematician.

Shanahan and Shanahan (2008), point out that "strong early reading skills do not automatically develop into more complex skills that enable students to deal with the specialised and sophisticated reading of literature, science, history, and mathematics". Reading in primary schools is different to reading in secondary schools, perhaps with the exception of English lessons – the transition has been described as being from 'learning to read to reading to learn' (Lee & Spratley, 2010). However disciplinary literacy does start in primary school with the introduction of non-fiction texts on different topics (EEF, 2023). Some studies have found that secondary school teachers – again, with the exception of English – tend to be resistant to teaching generic approaches to reading (Moje, 2008).

Shanahan and Shanahan (2012) also note that secondary schools tend to assume literacy competency which, given our selective cohort, is likely to be true at The Perse. While we do, to some extent, screen for basic literacy skills through our entrance testing, we do assume that most of our students can read and understand the texts we give them when our aim is imparting content. Is there scope here to raise standards further by improving literacy skills? Paige Boxhall looks at whether our existing metrics can predict scientific literacy, or whether it is indeed a specific and independent skill in her report on page nine.



How do disciplines differ?

The concept of an academic 'discipline' has been identified variously as 'a constellation of certain types of discourse' (Fries, 1999) and 'communities of practice' (Lave & Wenger, 1991). Between disciplines, what counts as evidence differs, as do the features needed to make an argument valid (Fries, 1999). Despite the vagueness of these definitions, construct validity has been established when comparing the skills needed to read History, Science, Maths and English (Spires et al., 2018); three factors emerge.

⇒ Source literacy
- Awareness of the importance of authorship
- Awareness of the importance of corroboration
- Awareness of the importance of context
- *This is most significant in History.*

⇒ Analytic literacy
- Reasoning with and deconstructing technical terms/ models/ graphs
- Being able to switch between representations
- Reaching conclusions through convergence
- *This is significant in Maths and Science.*

⇒ Expressive literacy
- Understanding the layers of meaning in text, such as the use of metaphor or other literary devices.
- *This is most important in English.*

Evidence does show that experts in one discipline approach reading and writing differently to experts in other disciplines (e.g. Shanahan et al., 2011). Indeed, many researchers have spent a great deal of time and effort describing the differences in tremendous detail (e.g. Lee & Spratley, 2010), only a few of which are included here.

Firstly, all disciplines have their own specialist vocabulary. But in science, words often have Greek or Latin roots, and categorisation tends to be hierarchical (e.g. mouse/ rodent/ mammal/ organism). Meanings in science are precise, and symbols may also be used (Shanahan & Shanahan, 2012). In contrast, in History, terminology can be metaphorical (e.g. Golden Age) and the meaning can be argued, with more sense of nuance (Shanahan & Shanahan, 2012). Readers face the challenge of understanding abstract terminology and unfamiliar language 'of the time' rather than difficult technical terminology (Shanahan & Shanahan, 2012). Maths has its own challenges, in that it uses familiar words but gives them precise meaning which only applies in maths such as 'difference' or 'similarity' (Fang, 2012). Symbols are used extensively but can be a constant (π), a variable (x), or a process (∫) (Fang, 2012).

Grammar, too, varies between disciplines. Science turns processes into nouns (e.g. evaporation, sublimation), thus removing any sense of agency, and often uses extended noun phrases (Fang & Schleppegrell, 2008). Graphs and diagrams are referenced in the text and form key parts of explanations. Maths also uses different modalities but these can appear within a single sentence (e.g. Kate ate *x* biscuits) and meaning can sometimes depend on context (e.g. '3 by 3') (Shanahan & Shanahan, 2012). In History, verbs are significant, as the author's choice of word can signal opinion (e.g. killed vs. slaughtered). Agency is highlighted and justifications and alternatives are offered (Schleppegrell, 2004).

Structure of both sentences and paragraphs also changes between disciplines. Narrative text is usually built out of simple clauses linked by connectives and/ or subordination (Fang, 2012). But in Science, clauses are linked by relation, and so complexity builds through the paragraph. The text is dense, with embedded clauses expanding on the original subject (Fang, 2012). The pronouns 'this' and 'these' are used extensively to refer back to a concept from the preceding sentence. Text is noun-heavy and brevity is sought (Fang, 2012). In Maths, every word matters – getting the gist is not enough – even making the distinction between finding 'an' answer and 'the' answer can be significant (Shanahan & Shanahan, 2008).

Awareness of the author is obviously of vital importance to historians. This is one way historians judge the reliability and value of a source (Wineburg, 1991). In Science, experts might use the author as a way of screening for quality (reading, for example, a student's work differently than an expert's), but the date is more important than the author and the method and reasoning more important still (Shanahan et al., 2011). In Maths the author is usually ignored entirely unless, like science, a novice author means errors are likely (Wineburg, 1991).

Finally, the way a text concludes varies by discipline and reflects the aims of that subject. In History, the argument must be plausible and supported by evidence, but can be disputed (Shanahan & Shanahan, 2008). The role of the historian is, then, to some extent, to convince. Historians also have awareness of their own bias (Shanahan & Shanahan, 2008). In science, by contrast, conclusions are more likely to be made tentatively and cautiously, because errors can result in huge risk. The aim here is that, eventually, the scientific community will reach a consensus, because they are all seeking universal truth (Shanahan & Shanahan, 2008).

It should be noted that research does tend to focus on those subjects which are *most* different. History is included in the vast majority of research and generally compared to a science – often Physics – or Maths. Is this because these subjects are as far apart as possible? Research into the differences between the sciences seems less likely to uncover significant variations. Interestingly, there seems to be a dearth of published research into literacy in Philosophy, Art or the social sciences. Donald MacLennan investigates what disciplinary literacy might include when studying languages on page fourteen.



What do experts do differently to novices?

As well as evidence showing that text in different subjects is constructed differently, there is a wealth of evidence showing that experts and novices approach reading tasks differently. This is hardly surprising as, when we read, we construct meaning using both the text and our existing knowledge and understanding (Tierney & Pearson, 1986). This means that it is much easier to read content that fits with existing knowledge of the topic itself, or of the structure of the text you are reading (Singer & Donlan, 1982). At secondary school, the regular movement between subjects means that students are switching between styles of reading multiple times a day – and if they do not, they will struggle. For example, if they try to comprehend a Science textbook using their knowledge of how to read narrative, they are likely to miss key topic content.

Research shows that Physics experts focus their attention only new or counter-intuitive content, jumping between sections, rather than reading linearly as novices do (Bazerman, 1985). They can switch between reading to learn about an unfamiliar topic and reading to criticise (Bazerman, 1985). Experts have been shown to approach problems differently, grouping them by deep similarity in their underlying concepts rather than by superficial similarity (Chi et al., 1981).

Experts in history have been found to question validity before engaging with the source text whereas novices do not question validity spontaneously even when exposed to multiple conflicting sources (VanSledright & Kelly, 1998). It seems that presenting sources in a synthesised selection, such as in a textbook, is even worse for stimulating questions about validity than a range of separate sources (Britt & Aglinskas, 2002) because, unlike experts, students do not make links between texts unless prompted to do so (Stahl et al., 1996). When pushed to identify sources they trust, students pick those which are longer and more detailed (VanSledright & Kelly, 1998), more realistically painted (Wineburg, 1991), more modern (VanSledright & Kelly, 1998), or which fit their general schema about what is likely to be true, for example choosing images of a typical battleground rather than one which matches known features of a particular battleground (Wineburg, 1991).

When reading poetry, perhaps surprisingly, experts spend longer reading than novices (Peskin, 1998). They also relate the poem to other examples within the genre and can anticipate and predict more (Peskin, 1998). However, this observation highlights a weakness of this entire strain of research; the conclusions are correlative rather than causal. Experts read differently but this seems more likely to be a consequence of their expertise rather than the reason they have become experts. Surely it is just as likely to be knowing more content that changes the way experts read rather than experts just reading in a different (and potentially teachable) style. If this is the case then teaching disciplinary literacy is just teaching content knowledge, which is what teachers do already – leading to the question of just what 'promoting disciplinary literacy' might look like beyond current good teaching practice.

A second problem with this strain of research is the methodology. A common technique is the 'think aloud' technique (Shanahan & Shanahan, 2008) where experts and novices narrate their thought processes as they read. There are two problems here. Firstly, this requires subject-specific oracy, which may be lacking. It is difficult, for example, for the novice historian to discuss source authorship, bias, and validity without these terms. They cannot use context or existing knowledge to make sense of what they read because they are, through definition, novices. Secondly, novices will, again by definition, find the task of reading specialist texts more difficult than experts, who have had more practice at this task. They are likely, therefore, to experience much greater cognitive load and asking them to then also narrate may overwhelm their processing capacity, leading to worse performance.



Teaching interventions

There is remarkably little available research into how disciplinary literacy can be taught, or indeed whether teaching using this approach has any measurable positive impact.

One possible avenue is to teach disciplinary specific oracy – the EEF suggests that learning to talk 'in the style of' the relevant discipline has a positive impact (EEF, 2021), which suggests that teachers should be specific with language in discussion and correct terminology use by students, even when the gist is right (Rainey et al., 2018). It seems likely that teachers are already keenly aware of the importance of using specialist vocabulary correctly as this is rewarded by the mark schemes of most qualifications – and already seek an appropriate balance between explanation clearly, meeting students where they are, and modelling use of more ambitious specialist terminology.

A second possibility is to use what is termed 'cognitive apprenticeship' (De La Paz et al., 2016; Graham & Perin, 2007a) which is thinking aloud whilst modelling a task, sharing cognitions (Hand & Prain, 2002; Rainey et al., 2018). There is evidence that this style of teaching improves the quality of writing in History (De La Paz et al., 2016; Graham & Perin, 2007). Harking back to a Vygotskian style of teaching, with an emphasis on modelling and explanation, this again seems very likely to be something that good teachers already invest in heavily. Some of the research appears to be working from a very low baseline, for example there are papers which report entire lessons, verbatim, as examples of this style of teaching, which, to an experienced teacher is just a report of a fairly standard lesson rather than one which might be held up as inspiration for a new method of teaching. Surprisingly, there is some evidence that suggests the cognitive apprenticeship technique is not always effective; one study found, in poetry teaching, that plentiful exposure to various texts was just as effective as the cognitive apprenticeship method (Smith, 1989) .

A third suggestion is 'functional language analysis', a more innovative approach. This consists of exceptionally detailed work unpicking the grammar of a text which is typical of the discipline (Fang & Schleppegrell, 2010). This is proposed to help learners understand the complex relations between subject and word class, for example the contrast in Science between 'being processes', which present definitions and descriptions (e.g. An organism *is*) compared to 'doing processes' (e.g. evaporation, sublimation, respiration). For instance, students could be asked to identify the appropriate noun in the previous sentence referred to by each pronoun (e.g. This process relies on… This temperature causes… This effect is…) This approach would require additional training of teaching staff and appears to be very time-consuming but it is a comparatively novel idea for most teachers which has potential to increase understanding of discipline-specific texts. Unfortunately, it has proved impossible to find any research assessing the impact of teaching in this way so at the point the idea appears to be untested.

Another option is to encourage students to take notes in a way specific to the subject to encourage focus on the relevant aspects of the text (Shanahan & Shanahan, 2008). For example, in Chemistry, students could summarise text using the headings substances/ properties/ processes/ interactions/ atomic expression. In History, by contrast, text could be summarised using what/when/where/why with extra emphasis on the 'who' and the careful sequential presentation of contradictory texts. An online system of this type developed for History was shown to have a positive impact on understanding (Britt & Aglinskas, 2002) which is encouraging. Additionally, there is evidence that this kind of approach improves engagement and enjoyment of students (Hynd-Shanahan et al., 2004). It is possible that the increase in enjoyment and engagement is what is driving the improvement, rather than the increased disciplinary knowledge, but it is at least an idea with some empirical evidence behind it.

Finally, Moje (2015) produced the '4 Es' heuristic for teaching disciplinary literacy:

⇒ Engage students in work that looks like real work from the discipline
⇒ Elicit and engineer opportunities to successfully accomplish classroom tasks
⇒ Examine words, language, representations
⇒ Evaluate words and ways with words across disciplines

At this point these ideas are good starting principles but have not as yet been developed into specific teaching strategies that can be implemented. The Perse's Sarah Mitchell looks at the use of disciplinary-specific scaffolding, comparing the effectiveness of structure scaffold and vocabulary scaffolds on page nineteen. Eleni Pepona reports on her trial of using university level texts in order to improve statistical literacy on page twenty-three.

Conclusion

While much of the research into disciplinary literacy has huge depth and qualitative detail, it is alarming to discover that almost all of it is theoretical in nature; the concept remains almost entirely untested in practice and indeed, with careful reading, many of the ideas would appear merely to (re-)describe existing practice. This may be a reflection of a variation in education systems, with most researchers based in the American system which is different in many ways. Dividing teaching along clear disciplinary lines is common in the British system and may result in more subject-specialist knowledge being shared with students early on. It seems likely that the lack of research into particular subjects (such as Geography, RE, and Computer Science), and the tendency to group Biology, Physics and Hhemistry as one subject also reflects the American school system. The importance of authorship, for example, is raised in most primary school History curricula and well established in the GCSE and A-level syllabi so is already taught extensively.

It is easy to understand why subjects that tend to focus on practical skills for novices (such as Art, Music and Drama) are missing from the research. However there also appears to be no research – theoretical or empirical – into the subjects that our system introduces only in the final years of school education such as Economics, Psychology and Politics. It is particularly important to consider these subjects as high levels of literacy are assumed by Sixth Form yet the style of writing will be new and unfamiliar to students. Perhaps more focus on disciplinary literacy may be most beneficial in these subjects. Thinking specifically about our cohorts, it may be that disciplinary literacy is less important due to our consistently high literacy levels (based on our entrance testing). Research suggests that literacy interventions tend to benefit the weakest students (Ricketts et al., 2014) which may render them less useful for a selective intake.

There is perhaps a more fundamental weakness to the concept of disciplinary literacy—or, at least, to how it could be misunderstood and misapplied as an approach. The ability to read text in the way a subject expert reads relies to at least some extent on content knowledge rather than just 'habits of mind' in the way one approaches text (Alexander & Judy, 1988). Previous educational 'innovations' such as noticing that successful children displayed growth mindset have been criticised for making assumptions about the direction of causality. We know now that educational achievement may drive growth mindset, rather than the other way around, making the time spent trying to foster growth mindset likely to be less effective than time spent on transmitting knowledge (Didau, 2017; Foliano et al., 2019). Perhaps disciplinary literacy is also a *consequence* of increased subject knowledge rather that a style of reading that *causes* an improvement in learning.

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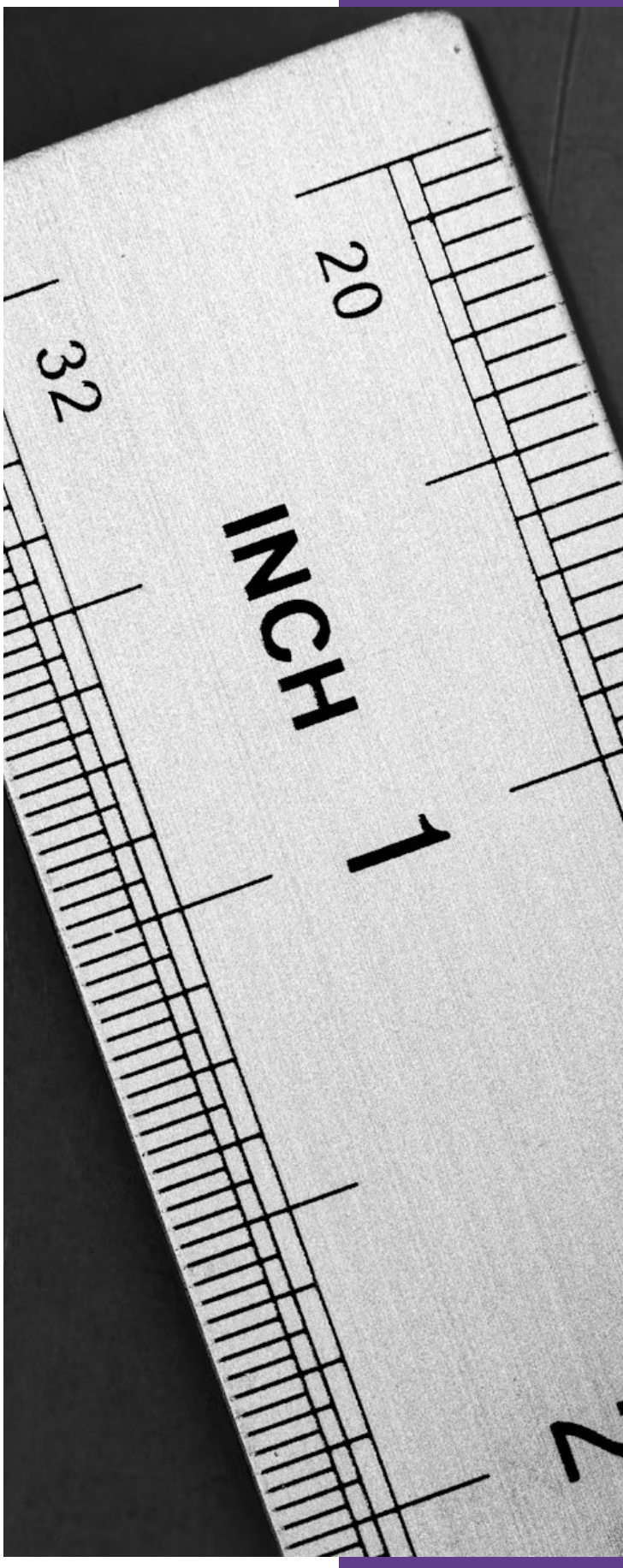
09

Developing a tool to assess scientific literacy: are existing educational metrics enough?

Paige Boxhall



Introduction

Scientific literacy is a key goal of science education, equipping students with both content knowledge and the ability to interpret and apply scientific information in real-world contexts. Yet, assessment practices often focus on factual recall or exam preparation, overlooking broader skills like reasoning, vocabulary, and conceptual understanding.

At The Perse School, Year 8 Chemistry students are assessed through classwork, topic tests, and entrance testing. However, these methods rarely measure scientific literacy holistically. This raises the question of whether existing tools inadvertently assess aspects of scientific literacy, or if a targeted approach is needed to gain deeper insight.

This action research project addresses that gap by designing and trialling a comprehension-based assessment using a real-world scientific article. The tool aims to challenge students in vocabulary, inference, context, and concept application. By comparing its results with existing entrance testing data, the project evaluates both the adequacy of current assessments and the potential of a teacher-developed alternative.



Literature review

In recent years, disciplinary literacy has gained importance in secondary education for its role in helping students engage with the specific literacies of individual subjects. In Chemistry, this means understanding the specialised language, concepts, and practices that enhance learning and support deeper engagement.

Research emphasises that disciplinary literacy involves more than general reading and writing skills. Shanahan and Shanahan (2008) define it as mastering the unique ways of thinking, reading, and writing within each subject, such as interpreting chemical formulae or writing lab reports. Similarly, Fang and Schleppegrell (2010) stress that students must become fluent in the technical language and conventions used to explain scientific phenomena.

Chemistry teachers play a key role in supporting students as they navigate complex texts, including chemical equations and scientific articles. Graham and Herbert (2010) found that focused writing instruction in Science, such as crafting hypotheses or explanations, improves both reading comprehension and conceptual understanding. Moje (2015) adds that students must critically engage with disciplinary texts, learning to interpret experimental methods and draw conclusions from data.

Beyond reading and writing, students also need to adopt the disciplinary practices of Science. Shanahan and Shanahan (2012) highlight the importance of skills like designing experiments and interpreting data. In chemistry, these practices are reinforced through lab work that requires students to communicate procedures and analyse results—both orally and in writing.

Effective strategies for developing these skills include explicit instruction in reading scientific texts, guided writing tasks, and integrating technical vocabulary into discussion (EEF, 2017). Graham et al (2017) support this approach, showing that it boosts both literacy and Science performance.

Hand and Prain (2002) argue that disciplinary literacy must be a central focus of science instruction, not just a secondary goal. By explicitly teaching the literacy demands of Chemistry, educators help students build the skills necessary for academic success and real-world application.

Methodology

Participants

The participants in this study were all Year 8 students at the school, who were enrolled in Chemistry classes at the time of the project. The assessment was administered to each class within a few weeks, during their regular Chemistry lessons, and under the supervision of their Chemistry class teacher. A total of 145 students participated in the assessment.

To ensure the inclusion of all students and to collect as comprehensive data as possible, adaptations were made for students with specific learning needs. This included accommodations such as extra time for students who were entitled to it and the provision of coloured paper for students who required this adjustment. Students who were absent on the day of the assessment were not included in the data collection.

Teacher-Developed Assessment Tool

The teacher-developed assessment tool is a comprehension exercise designed to assess Year 8 students' scientific literacy through a series of 22 multiple-choice questions based on an article titled *The Smell of the Kitchen* (Masciulli et al., 2022). The students were given 40 minutes to read the article and answer the questions, with an additional 10 minutes (50 minutes in total) for students who were entitled to extra time due to learning support needs.

The tool was designed to test students' ability to connect terminology to broader scientific principles, challenging them not just on definitions but on understanding how scientific concepts interrelate. The questions are varied in type, incorporating definitions, applications, and reasoning. The questions are categorized based on the skills being assessed, including:

- ◊ **Prior learning:** Questions that require students to recall and apply prior knowledge of scientific terms and concepts
- ◊ **Diagram literacy:** Questions that assess the ability to interpret scientific diagrams
- ◊ **Vocabulary comprehension:** Questions that assess the understanding of scientific terminology such as "carbonyl group," "pyrazines," and "synthesis."
- ◊ **Contextual understanding:** Questions that assess how well students can extract and understand scientific concepts within specific contexts (e.g., "enzymes" in a reaction or "temperature threshold").
- ◊ **Conceptual application:** Questions that require students to apply concepts like chemical reactions and the Maillard reaction to specific scenarios.
- ◊ **Inference and reasoning:** Questions that require students to make inferences or reason through scientific principles

Assessment adjustments

I made sure to signpost where relevant information could be found within the article, to ensure that students' performance was based on their scientific literacy skills, rather than their ability to locate the necessary information in the text. This approach was taken to allow students to focus on understanding the scientific content rather than struggling with the reading process itself.



Ethical Considerations

The research was approved by the school's ethics board prior to beginning the assessment. In line with ethical guidelines, informed consent was obtained from all participants. Students were made aware that their participation was part of a research project and that their results would be anonymised. To ensure privacy, all identifying details were removed from the data. Additionally, offering the assessment to the whole Year 8 cohort helped to ensure that no individual students could be easily identified, thereby maintaining their confidentiality.

Results and Analysis

This analysis aimed to determine whether existing academic and support metrics are related to students' performance on a teacher-designed scientific literacy assessment. The goal was to assess the validity of the tool by identifying whether it aligns with established indicators of ability.

Understanding the Statistics

To measure relationships between variables, Pearson's correlation coefficient (r) was used. This value ranges from –1 (perfect negative correlation) to +1 (perfect positive correlation). A t-value is a test statistic that helps determine if a correlation is statistically meaningful. The p-value tells us the likelihood that any observed relationship occurred by chance. In educational research, a result is typically considered statistically significant if $p < 0.05$.

Please note that the sample size (n) varied for each of the entrance testing metrics, depending on which students had complete data sets available. Students who were absent or did not complete the literacy assessment were excluded from the analysis.

Correlation with existing testing metrics

The assessment showed the strongest correlation with MidYis Overall scores ($r = 0.45$, $p < 0.001$), suggesting strong alignment with students' general academic ability. MidYis Vocabulary also had a strong, significant relationship ($r = 0.41$), reinforcing the importance of vocabulary in scientific literacy.

Moderate correlations were found with other MidYis components, such as Math, Non-verbal, and Skills ($r \approx 0.26$–0.30), and the CAVE score ($r = 0.30$), all significant at $p < 0.01$.

Among the entrance testing metrics, the average score across all completed assessments showed a significant correlation ($r = 0.38$, $p < 0.001$). This suggests a cumulative literacy profile may be more predictive than individual subskills. Metrics such as Spelling, Reading, and Segmenting showed weaker but still statistically significant correlations ($r = 0.21$–0.30). However, the NonWord score did not show a meaningful relationship ($r = 0.08$, $p = 0.16$).

Overall, the analysis suggests that the assessment tool aligns well with established indicators of academic and language ability.



Performance by Literacy Skill Category

Each assessment question was categorised based on the type of literacy skill it required, with some questions belonging to more than one category. The average percentage score achieved in each category is shown below:

Area assessed	Average score (%)
Prior learning	87
Diagram literacy	67
Vocabulary comprehension	77.3
Contextual understanding	73.1
Conceptual application	69.2
Inference and Reasoning	59.5

These results suggest that students were most successful in questions related to prior learning and vocabulary comprehension, areas typically reinforced through classroom instruction and revision. However, scores declined in categories requiring deeper scientific literacy, such as inference and reasoning (59.5%) and conceptual application (69.2%). These findings highlight that while students may have a strong command of taught content and terminology, they find it more difficult to apply that knowledge to unfamiliar contexts or to make inferences based on information in the text.

Implications for Teaching and Assessment

These findings underscore the need for more targeted, skill-specific assessments that go beyond factual recall and engage students in the kinds of thinking required in real-world science contexts. The bespoke assessment tool trialled in this research appears to serve that function well, particularly by differentiating between types of literacy demands.

For teachers, this suggests an opportunity to place greater emphasis on teaching and modelling scientific reasoning, as well as helping students make connections between vocabulary and broader conceptual frameworks. For schools, it raises the question of whether traditional entrance assessment metrics should be complemented by discipline-specific tools that can better identify students who may need additional support in science.

Limitations

While the sample size aimed to be as large as possible, there were some limitations that affected the analysis:

Absenteeism: Not all students were present on the day of the assessment, meaning the sample did not fully represent the entire Year 8 cohort. This reduced the generalisability of the findings slightly.

Bias in Question Design: As the assessment was teacher-developed, it is subject to my own biases in terms of what I perceive to be an effective and appropriate way to assess scientific literacy. My understanding of what constitutes good question design, particularly for Year 8 students, could have influenced the difficulty and appropriateness of the questions.

Entrance testing data: Some entrance testing data was unavailable for certain students, which meant they could not be included in the analysis, for this reason for some tests the number of data points is less than 145. This reduced the sample size for the correlation analysis between the literacy assessment score and these metrics.

Reflections on Assessment Structure

The variety of question types allowed for a broad sampling of skills, but the high number of vocabulary-based items may have skewed the overall average upward, masking weaker performance in reasoning-based tasks. Furthermore, while questions were directly tied to a single scientific article, this dependency may have limited transferability; students were being assessed not just on scientific literacy, but on their comprehension of that specific text.

Nonetheless, the results demonstrate the diagnostic value of a carefully structured assessment that differentiates between types of scientific thinking. The difficulty students had with inference and conceptual application underscores the importance of explicitly teaching these skills, which are not always prioritised in traditional science assessments.

13. **Go to the section named The Maillard reaction makes food look good. What is the role of a melanoidin?**

A) A molecule responsible for the development of sweetness
B) A substance that decreases the boiling point of pyrazines
C) A compound that acts as a natural preservative and gives food a brown colour
D) An chemical that speeds up the reaction process

17. **Go to the section named Flavour is set during the advanced stage. What does enhance mean in the context 'the Maillard reaction can enhance the flavour of food'?**

A) To permanently change a substance
B) To modify the texture of food
C) To improve or intensify the flavour
D) To balance the chemical properties

Conclusion

This analysis set out to explore the extent to which a teacher-designed scientific literacy assessment aligns with existing academic and support metrics, with the aim of validating the tool and understanding how well it reflects the multifaceted nature of scientific literacy among Year 8 students.

The correlation data clearly show that the assessment relates strongly to established indicators of academic ability, particularly MidYis Overall and Vocabulary scores. These findings suggest the tool effectively captures key components of scientific literacy, especially those linked to language and reasoning skills. Moderate correlations with entrance assessment metrics, and a particularly strong relationship with averaged scores across these, reinforce the idea that scientific literacy is best understood as a combination of skills rather than a single attribute.

Analysis of student responses by skill type further supports this conclusion. While students performed well in areas such as vocabulary comprehension and prior knowledge recall, they struggled more with conceptual application and inferential reasoning—skills that are central to deeper scientific understanding. This highlights a critical gap not always addressed by traditional assessments.

Given these findings, the bespoke assessment appears to provide added diagnostic value beyond existing metrics. However, an important next step in evaluating its true utility would be to assess how well it predicts long-term outcomes. Specifically, future analysis could compare the predictive strength of this tool, alongside traditional entrance metrics, against students' Year 9 end-of-year science results and, ultimately, their GCSE outcomes in Year 11. This approach would offer more definitive evidence as to whether a dedicated scientific literacy assessment is needed, or whether existing measures are sufficient.

In the meantime, the results support the case for more targeted, subject-specific literacy tools and instructional strategies in science. Developing students' ability to interpret, reason, and apply knowledge in unfamiliar contexts is crucial—not just for examination success, but for developing scientifically literate young people equipped for the demands of the modern world.

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DISCIPLINARY LITERACY AND THE STUDY OF LANGUAGE

Donald MacLennan



Introduction

Educational research on 'disciplinary literacy' aims to understand and qualify the additional skills and knowledge required both to understand and to express ideas in different academic disciplines. Research has focused particularly on scholarship in History, Mathematics, and Physics. It has shown, perhaps unsurprisingly, that research on theoretical Physics, for example, is distinct in its aims, lexicon, and grammatical structure to a paper written by an historian. The particularly interesting outcome for our purposes is that researchers suggest we incorporate study of these discipline-specific skills into the practice of teaching and learning. The argument goes that if we teach students how to read and write like historians, mathematicians, and physicists, they are more likely to succeed in those subjects.

In this study, I aim to apply the principles of 'disciplinary literacy' to the study of language itself. I have chosen this area not only because it is an area of personal interest or because it is an area neglected by existing research into 'disciplinary literacy', but also because the way in which we investigate, teach, and learn language potentially has a disproportionate impact on the development of literacy in general. It could, therefore, be particularly significant for our overarching aims in evaluating and discussing 'disciplinary literacy' as a means to foster literacy in the school.

The 'study of language' is intentionally a broad definition of a 'discipline' in this context. The study incorporates philology (the study of historical languages) and linguistics and literary studies in modern languages, including both English and Modern Foreign Languages. In what follows, I will point out the differences between these different areas but also highlight the similarities in order to draw some meaningful cross-curricular conclusions that might impact how we teach and learn language more broadly.

The study, therefore, aims to identify key features of 'disciplinary literacy' in the study of language – focusing on aims, lexicon, and grammar – and tentatively makes some suggestions of how this might impact teaching and learning. The suggestions that I make should not be taken to be certain or necessary steps that we must take to improve the teaching and learning of language in schools. The suggestions are intended to spark thought, discussion, and reflection on our practice.

Methodology

The paper identifies key markers of 'disciplinary literacy' based around three areas commonly discussed in research on 'disciplinary literacy': aims, vocabulary, and grammar. In order to find a representative sample of research in the fields under discussion, I have taken a sample from journals with relatively high 'H-index' ratings from each. Whilst the 'H-index' is not necessarily a marker of research quality, it should give an indication of what is normal for the study of language broadly defined.

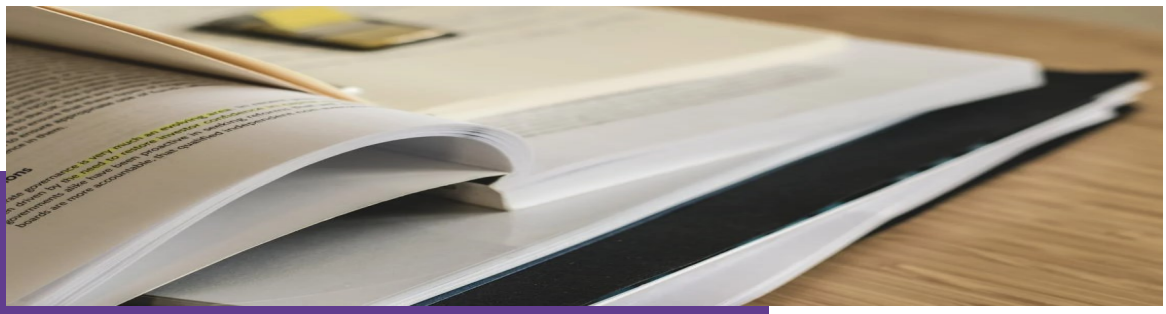
There are certainly limitations to this method: the research I have read may only be representative of very recent work or perhaps only representative of a certain group of journals in that field. My work has been based primarily on journals – chosen because they can be easily accessed as well as rated and directly compared with their 'H-indices' – to the exclusion of books, magazines, and other forms of research. This decision, too, might lead to a skewed representation of research into these fields. Nevertheless, I hope that, by taking a recent and commonly referenced sample of peer-reviewed research, I can make some useful conclusions about 'disciplinary literacy' that will have some worth in discussions about language teaching. The results are presented below in three sections: aims, vocabulary, and grammar. In this context, I cannot present fine detail of all the research undertaken to reach these conclusions. In what follows, I give some illustrative examples of the distinctive phenomena I have identified, but it is certainly not exhaustive. The bibliography below includes details of all surveyed papers that went into these conclusions.

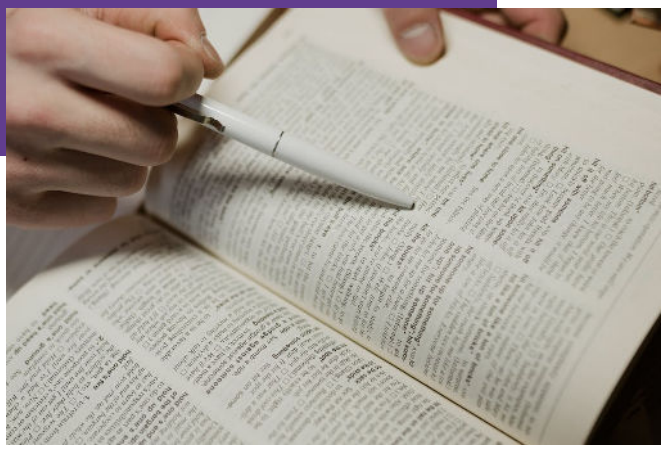
Aims

The first area of investigation is the aim of research, and the types and thresholds of evidence used within it. In some ways this question goes beyond the typical study of 'disciplinary literacy' and is fundamental to what characterises and delimitates the discipline. Disciplines are often defined by a shared approach towards evidence – what constitutes evidence and what we can do with it: validity of argument – what might be a valid argument and what might not; and research aims. Within the context of this study, the aims of scholarly research into language present an important barrier to our students' engagement with and expression of ideas and, thus, I think it is a useful point of discussion.

Within the study of language, research does not seem to focus on static language *per se*. Articles on English linguistics do not discuss how to speak English, nor do papers on foreign languages, both ancient and modern, focus on everyday language. Research in linguistics tends to be applied to particular cases or unusual scenarios. Papers on Classical Philology will often discuss the language of a particular text (even the interpretation of a small part of a text) or the language used by a particular author. Researchers in modern linguistics will study either particular parts of literature or unusual occurrences in the target language, including different dialects, situations, or unusual variations.

Whilst scholarly focus on the exceptional, new, or divergent is perhaps unsurprising, it raises interesting questions regarding the link between language teaching in schools and the ideas behind the study of 'disciplinary literacy'. Based on these findings, we might suggest that language teaching where possible should involve not only the acquisition of 'typical' language, but also the application of this knowledge to other situations. It would suggest that we should be, for instance, analysing the contrasts between divergent dialects, reading literature in the original language and discussing the unique elements of that author, or applying the language to unusual situations.





Vocabulary

The language of research in some disciplines has been extensively analysed as part of the discussion into 'disciplinary literacy'. It has been shown that while Maths and the Sciences use precise terminology and technical terms and symbols, subjects like History or English use more metaphorical language and some everyday terms that require nuance to understand in the given context.

The study of language uses a mixture of different lexica, including some traits that are more similar to Maths or Science, and others that are more like History and English. Looking at the surveyed articles, we can see one distinct lexicon in articles discussing language itself, which can use a series of different grammatical terms that differ depending on context. Philology will often include specialist terms to describe the grammar used in literature. Research into modern languages seems to be split between those that focus on one language only (including linguistics or literature) and comparative linguistics. The former uses technical grammatical language quite sparingly, but the latter makes it a prime focus of the discussion. In each case, the expected familiarity or unfamiliarity of the target language seems to drive the level of technical language used in the discussion: grammatical terms appear either for more obscure languages or for research that spans multiple languages, whilst research into one modern language assumes more knowledge and does not rely as much on technical terminology.

On the other hand, research into language as it pertains to literature will sometimes use a different set of technical terms. Philologists will use terms like 'anaphora', 'hendiadys', or 'chiasmus' to describe literary and rhetorical techniques. At the same time, this appears to be less common in studies on modern literature, which discuss similar ideas and traits without using the same technical vocabulary.

Whilst we do see a disparity in the frequency and type of technical language used by the different types of linguists studied, there is a common theme in the types of language used more broadly. Unlike research in History, Maths, or English, linguists use two distinct modes of practice within their work and switch their vocabulary to match. Scholars use precise terms with exact meanings when discussing the workings of language; this is not unlike the way in which Mathematicians use precise vocabulary. On the other hand, linguists use vocabulary much more similar to that used by Historians when discussing literature, including metaphorical uses of everyday terms and broader vocabulary that takes greater nuance to understand.

We can make some observations here about the vocabulary we use in teaching and learning. There are some significant differences between the different types of linguists in terms of technical vocabulary. Based on the ideas behind educational research on 'disciplinary literacy', it will be important for Latinists and Hellenists to learn technical vocabulary typical of that discipline, whilst this seems to be less important for the study of Modern Foreign Languages. Teachers will also need to be aware of the different genres – linguistic and literary – of technical vocabulary and consider whether their students need to know each type of language to engage with research in that particular discipline. For all studies of language, we should be aware that there are two broad lexical sets and that we need to be able to switch between them, modelling when to use exacting terminology typical of grammatical analysis and when to use broader terminology typical of literary analysis. We could explicitly teach the two sets of terms and when to use them or otherwise model them carefully during discussion.

Grammar

In a similar way to the shift from exacting to metaphorical vocabulary when discussing language or literature, we can see two distinct modes in the grammar employed by linguists in their research. On the one hand, linguists will use indicative verbs (e.g. mean, equal, state, follow) in exacting fashion, combined with the technical language mentioned above, to describe the meaning of language. There are, however, exceptions to this: in some cases, where the language is more opaque or uncertain, they will switch to uncertain verbs and grammatical forms more akin – following the methodology of 'disciplinary literacy' – to Historians than Mathematicians. In Helms' article on the often fragmentary and challenging Safaitic graffiti from Pompeii, for instance, he switches between indicative and subjunctive moods depending on the security of the reading in each case. On the other hand, research on literature will use uncertain verbs (e.g. infer, evince, suggest, imply) to describe their conclusions, taking language features similar to those identified amongst the work of Historians. This is perhaps unsurprising, but it is a distinctive element of research on language, which is capable of switching conceptually and grammatically between linguistic and literary discussion.

The other distinctive grammatical feature that seems common to linguists is the use of the other languages within academic writing. Studies of language of all types will insist upon using the original rather than a translation in discussions about a text or language. A surveyed article about the poet Ovid, for instance, picks out the verb *errare* ('to wander/err') as a vital metaphor in the poem: "I think *errare* is the best metaphor available…", and then refers to the participants in the poem as *errantes* ('wanderers'), using a participle of the same verb: "…figures as well as reader of Catullus 64 are *errantes*." In this case, the Latin is used mid-sentence and not translated for the reader. Other types of research can differ from this practice: a surveyed article about a modern linguistic family in the Amazon basin, spoken by very few people, instead uses a table that lists and translates each word under discussion, identifying each with a unique number that is then used in the main body of the text in lieu of the word itself. The context here matters greatly to the form of the research: in the former case Tamas assumes that his readers will understand the Latin, but the same cannot be said for the Labrada's study of the Amazonian dialect. In both cases, however, the authors find a way to explicitly and directly discuss the language itself without use of a translatory intermediary.

The study of grammatical features of linguistic research allows us to make some tentative recommendations for teaching and learning. As we discussed with reference to vocabulary, we should be modelling two different modes of speaking within our classrooms and should, therefore, be dealing with both language and literature (or at least certain and uncertain contexts) within our classrooms. We may need to model the aims of research on language, shown in the 'aims' section above, in order to model and teach the discipline-specific grammar. We should also be ensuring that students are comfortable using quotes in the original language to explain their ideas, even when discussing their ideas primarily in English.

Conclusion

In this article, I have identified four distinctive elements of research into language, broadly defined, and made some suggestions as to how we might develop teaching and learning based on those findings. As part of this project, I looked into what we are currently doing at The Perse in the relevant subjects: English, Modern Foreign Languages, and Classics. It is pleasing that we are already doing much of what is discussed above: students are frequently being asked to apply their linguistic knowledge to different cases and scenarios; they are reading texts in the original languages and discussing them using appropriate terminology; both students and teachers are using appropriate vocabulary and registers to discuss linguistic and literary questions. Any outcomes of this research, therefore, should be iterative rather than revolutionary. As teachers and practitioners, we have been trained in discipline-specific skills and conventions of our subjects, and we will naturally include these conventions in our teaching. I hope that the recommendations presented here can be used to support continuing discussions about best practice and spark new ideas about how to best support students.

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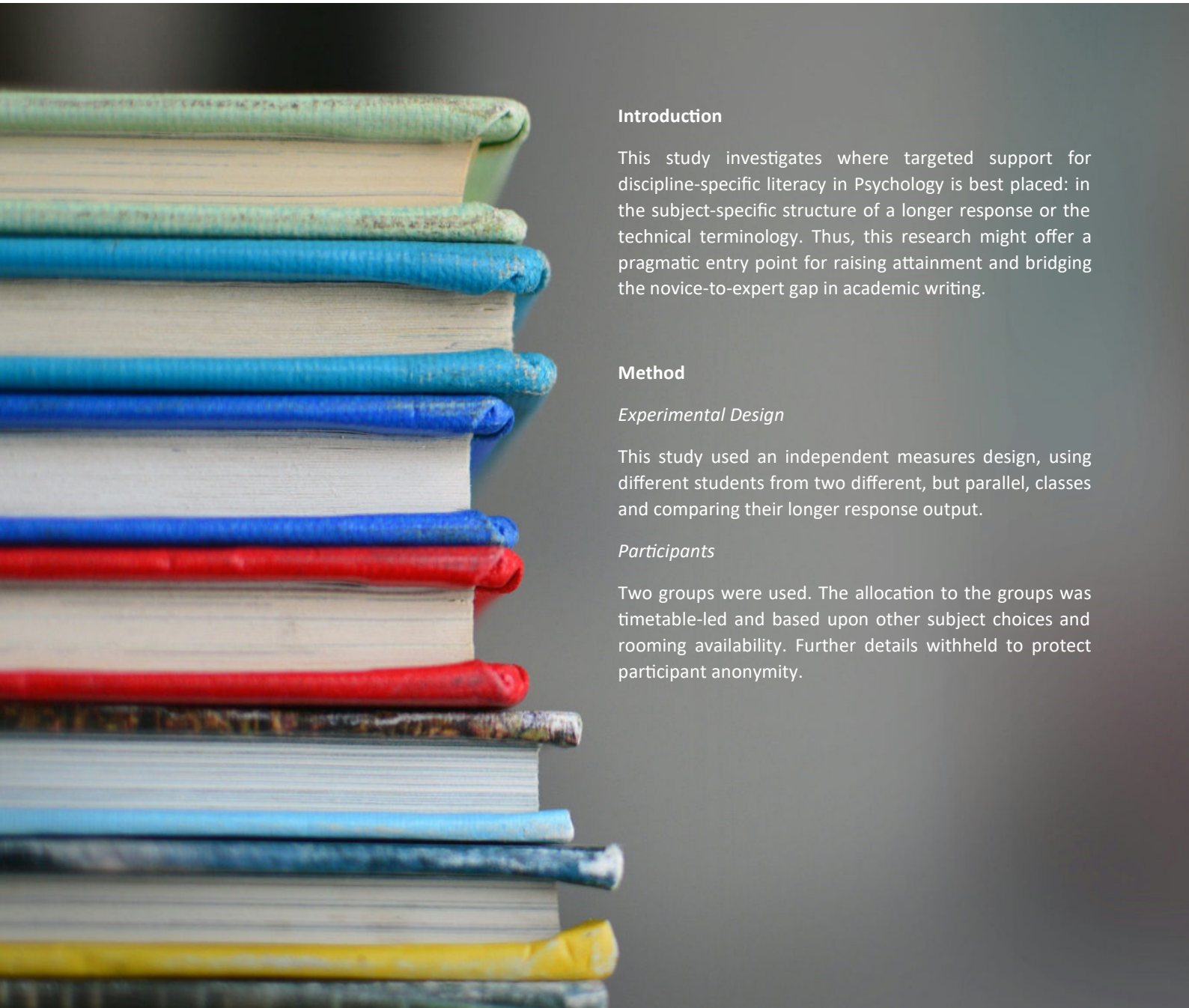
19

Big Vocab Energy: The Real Flex in Disciplinary Literacy

Sarah Mitchell explores the Impact of lexical versus structural scaffolds in Psychology essays



Introduction

This study investigates where targeted support for discipline-specific literacy in Psychology is best placed: in the subject-specific structure of a longer response or the technical terminology. Thus, this research might offer a pragmatic entry point for raising attainment and bridging the novice-to-expert gap in academic writing.

Method

Experimental Design

This study used an independent measures design, using different students from two different, but parallel, classes and comparing their longer response output.

Participants

Two groups were used. The allocation to the groups was timetable-led and based upon other subject choices and rooming availability. Further details withheld to protect participant anonymity.

Procedure

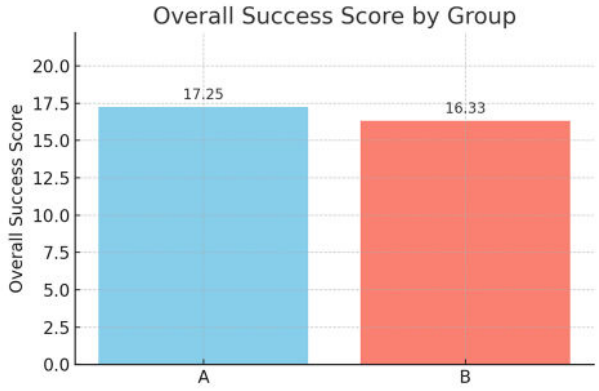
All participants came to their usual, timetabled 40-minute psychology lesson. The participants were provided with an essay title, which was the same for both groups. Beneath the title Group A saw a prompt reminding them about structure and outlining what would be expected, while Group B saw a prompt reminding them of a list of key words they could use in their response. All participants used OneNote to handwrite or type their plans and essays.

The researcher then copied the work to another file on OneNote, meaning that the responses could not be added to by the participants beyond the 40-minute lesson. A second researcher then removed any identifying information which indicated which group each response had come from, anonymising all responses, and listing them randomly in the OneNote.

The first researcher devised a marking grid of all the necessary elements of psychological disciplinary literacy (available on request) and gave a score, on a three-point scale (absent/emerging/secure) to each aspect of disciplinary literacy. This gave an 'overall success score' to each response, as well as an indicator of how well the target ideas of 'use of subject-specific terminology' and 'clarity of structure' had been realised in each response.

The responses were then de-anonymised so that the data could be grouped by experimental condition.

Results



Graph 1: overall success scores for Group A (structure prompt) and Group B (vocab prompt)

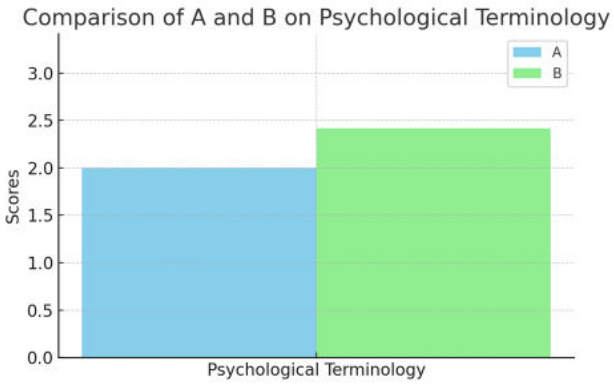
The average 'overall score' was calculated for both groups. This was higher for Group A (structure prompt) than Group B (vocab prompt).

When the average ALIS score was calculated for each group, it became clear that greater success was correlated with higher ALIS scores.

	A	B
SUCCESS SCORE	17.25	16.33333
ALIS	120	111.8

Table 1: average ALIS scores and experimental results for Group A (structure prompt) and Group B (vocab prompt)

The 'clarity of structure' score was the same for both groups.
The 'use of subject-specific terminology' score was higher for group B, who had seen the 'psychological terminology' prompt.



Graph 2: psychological terminology scores for Group A (structure prompt) and Group B (vocab prompt)

Discussion

The findings suggest that providing students with subject-specific terminology improves the response output in terms of disciplinary literacy more than reminders about the clarity of structure required in psychology essays.

This finding has important implications for educational practice, particularly in subjects such as Psychology that blend conceptual knowledge with evaluative writing.

The result of this study suggests that students benefit more from explicit instruction in the language of the discipline than from general guidance on essay structure. This is significant because it supports a growing pedagogical focus on embedding academic language development within subject teaching, rather than treating literacy as a generic skill (Shanahan & Shanahan, 2008).

In practice, this means that educators in Psychology (and likely other subjects) might consider allocating more instructional time to modelling and reinforcing key terms, theoretical vocabulary, and discipline-specific phrasing. Such an approach could better prepare students not only for assessments but also for deeper engagement with subject content. Research by Fang and Schleppegrell (2010) supports this, noting that subject-area learning depends heavily on mastery of its linguistic conventions.

This approach could also help to close the attainment gap. Students from disadvantaged backgrounds or those with English as an additional language often struggle with the academic register required in exams (Myhill, 2010). Explicit vocabulary instruction could therefore serve as a tool for equity, helping to demystify disciplinary discourse and allowing broader access to success in written tasks.

There are wider implications for curriculum design and teacher training. The results suggest that curricula and teacher development programmes might benefit from emphasising subject-specific language instruction. For example, exam boards could be encouraged to make clearer how terminology use is weighted in marking criteria, or to provide exemplars that demonstrate effective use of subject-specific language.

Additionally, the findings support a shift from teaching essay writing in a more nuanced way that focuses on conceptual understanding expressed through appropriate language. This could foster more insightful student responses that better reflect the rigors of the subject they are studying.

While this study helps to flesh out the bare bones of the concept of disciplinary literacy, offering a practical suggestion for teaching, some limitations should be acknowledged.

Firstly, there is a limited scope and sample. Research conducted in a single school or classroom, has limited generalisability of the findings. Different contexts—such as vocational settings, different age groups, or other disciplines—might yield different results.

Similarly, this research focuses on a limited snap-shot of measurement, looking at a single piece of work, rather than a whole body of output across two years of teaching. As such, it is unclear whether the benefits of vocabulary instruction are sustained over time or whether they contribute to long-term improvements in disciplinary literacy.

Depending on how disciplinary literacy is assessed, and how other markers might have placed more emphasis on different Psychology-specific qualities in writing, there may be limitations in capturing the full range of student understanding.

Similarly, it could be considered that providing students with a list of vocabulary to ensure use in a written task is actually a step too far in terms of scaffolding. Having such terms available before any thought has gone into the planning of the essay could act as a retrieval cue, which would not be present in an exam, and could lead to an over-reliance on such suggestions, rather than helping the students to develop their own strategies for learning and consolidating the use of subject-specific language. Thus, such vocabulary lists should be used with caution, perhaps only in the beginning stages when developing disciplinary literacy in A-level-only disciplines.

In terms of further study, it would have been helpful to cross over the design of the experiment and, on a different essay, provide the other prompt, so Group A would be given a second task where they are reminded about psychological terminology and Group B would be prompted to remember the clarity of the structure expected of them in a psychology essay in order to determine if such word lists are useful in general in improving disciplinary literacy or if they are particularly suited to certain groups.

Conclusion

In conclusion, this research adds to a valuable and growing body of work suggesting that vocabulary and subject-specific language are central to student success in essay-based subjects. It suggests that providing students with subject-specific terminology improves the response output in terms of disciplinary literacy more than reminders about the clarity of structure required. Future research might build on this by exploring how such instruction can be integrated across different subjects and educational phases, or how it can be tailored to support underachieving groups. Additionally, investigating the long-term retention of such vocabulary and its transferability to new tasks would further enrich understanding of its impact.

See the literature review for references

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22

Improving mathematics literacy in a Further Statistics classroom

Eleni Pepona

Introduction

Being a mathematician is not just about being able to accurately execute algorithms and procedures one has drilled many a time, but to be able to reason mathematically, to identify patterns and links between different areas of and concepts in Mathematics, to solve problems one has not encountered before, and to be able to effectively communicate such insights and solutions.

One of the biggest challenges in Mathematics education today in the UK is the development of mathematical disciplinary literacy (Quigley, 2024). When we think about literacy in natural languages, we have the image of an individual who engages widely with literature, can read critically, is able to understand other people's ideas and express their own views (Bullock, 1994). Similarly, in Mathematics, we can think of an individual who can reason mathematically, is able to critically read mathematical texts and is able to communicate mathematically, both verbally and in written form. In my 17 year long career in Mathematics education, I have experienced time and time again Quigley's (2024) *failure* of our collective instructional practice in producing young mathematicians that can effectively communicate their reasoning in written form. In order to effectively develop mathematical literacy we must fully immerse our students in mathematical discourse, and the ways of being a mathematician.

Teaching as initiation in a community of practice

Rooted primarily in the work of Lev Vygotsky (Vygotsky, 1978), the sociocultural theory of knowledge emphasises that human psychological processes develop as a result of continuous interactions of individuals with their social world. Learning and development take place in and through *shared, collaborative activities* mediated by the use of cultural tools. Cultural tools embody collective experiences; ways of thinking and knowing, rules of conduct, templates of problem solving. Central to Vygotsky's theory is that teaching-learning leads development. In the "zone of proximal development" individuals cooperate and are mutually involved in actively co-constructing their knowledge and understanding; knowing and acting are never separate. To know something is not to have some inner facts stored in the mind but the ability of an intentional human being to carry out, participate in, continue and ultimately, contribute to collaborative practices through one's own actions.

Working under this sociocultural constructivist approach, Lave and Wenger (1991) argue that all learning is situated; knowledge is inextricably tied to the *communities of practice*, the context and activities, in which it is learned. Newcomers to a community of practice learn by engaging in *legitimate peripheral participation*—starting on the margins of a community and gradually moving toward full participation, through social interaction with more knowledgeable others. To be a full participant in a community of practice is to be able to effectively use its technology, i.e. its tools, language and symbols. Initiation in a community of practice is equivalent to initiation in the community's *discourse*.

Being a mathematician or 'doing' Mathematics can be viewed as a discursive activity that involves participating in a community of practice using multiple material, linguistic and social resources (Moschkovich, 2007). Learning Mathematics, then, can be seen as initiation in mathematical discourse that involves developing shared practices, and becoming fluent in the Mathematics register (Halliday, 1978; Pimm, 1987; Moschkovich, 2007). Mathematics is constructed through language that is conceptually dense and highly structured in unfamiliar ways, to the extent that it is often seen to people outside the community as interpersonally alienating (Schleppegrell, 2010). It incorporates symbolic language that developed out of natural language, and uses visual displays to convey complex meanings. The linguistic means adopted in communicating mathematics are crucial also in the development of mathematical thinking and so, in teaching Mathematics, educators need to be explicitly focusing on students becoming familiar with the register of mathematics rather than assuming that fluency in will develop as a by-product of engaging in the discipline (Ferrari, 2004). In other words, to initiate a newcomer to mathematical discourse one needs to use the relevant terms, concepts and literacy practices. Introduction to formal mathematical signifiers is the beginning of the journey, not the destination (Sfard, 2007). As Mathematics educators, our role then is to scaffold and support our students' development of mathematical literacy.

Literacy instructional strategies in Mathematics

How does one become literate in Mathematics? As per the above discussion, development of mathematical thought goes hand in hand with development of the ability to critically read mathematical texts (a solution to a mathematical problem, a proof, a mathematical explanation, a mathematics textbook or article) and be able to construct mathematical narratives.

In the first instance, a student must be given access to rich mathematical level-appropriate literature. When a student meets text, the meaning they will create largely depends on their prior knowledge and experience in decoding such texts and their level of critical analysis skills in reflecting and thinking about the text. To comprehend a text is to come to construct a meaning from the text that is compatible with the author's intended message (Draper, 2002). To facilitate this process comprehension activities can be designed to provide the support necessary for students to work in their zone of proximal development. Such activities can include but are not limited to:

- The *Directed Reading-Thinking Activity* (DRTA) (Stauffer, 1969) encourages students to be active and reflective readers by asking students to make predictions or think about answers to some questions, then read / re-read a passage to confirm their understanding.
- The *Guided Reading Procedure* (GRP) strategy (Manzo, 1975) involves students recalling and recording the information they have read and self-correcting their narrative by referring to the original texts. A teacher can facilitate this process by asking prompting questions and providing corrections or guidance as necessary.
- The *Anticipation, Realisation, Contemplation* (ARC) strategy (Vaughan & Estes, 1986) involves the teacher having prepared a list of statements that the students are asked to read and comment on (eg. agree/ disagree) before and after the text is introduced.

Consistent exposure to mathematical texts in addition to the teacher's own notes and demonstrated examples, can create a culturally rich environment in which the students begin to appreciate and internalise the language of Mathematics. When attempting to create their own narratives, the following strategies can be used for guiding the development of written communication skills (Brozo & Crain, 2018). In preparation for and during a written task, a teacher can:

⇒ Ask students to articulate what the task is asking them to do before they get started.

⇒ Generate a plan for solving a problem, by describing the steps to be taken. This can be in the form of a mental map verbally explained or a plan recorded on paper as a flow diagram or as a narrative.

⇒ Justify the rationale for any calculations or operations used as part of a solution.

⇒ Ask students to consider alternative approaches to their chosen method by comparing their narratives with those of others, or creating an alternative solution, where appropriate.

In addition to the above, we can support the development of metacognitive skills by asking students to reflect on their writing by comparing it and/or grading it against a respective model answer or rubric.



The case for richer literature in A-level Mathematics

In the transition from GCSE to undergraduate level Mathematics, A-level courses in Mathematics serve to be the medium that take learners from being casual mathematicians towards being expert mathematicians. Even though undergraduate textbooks in Mathematics and their applications (like Statistics, Physics and Engineering) require students to be able to read rigorous mathematical narratives, little is available commercially to bridge the gap from the level of GCSE Mathematics textbooks to first year undergraduate textbooks. For example, A-level textbooks offer few formal definitions, are hasty in the introduction of notation, routinely skip proofs of theorems and results, even when these are within the reach of students based on their prior knowledge, and routinely skip from one topic to the next without any visible connection, introducing mainly techniques as opposed to mathematically discussing a topic in depth and creating a narrative that can link topics together.

As an examiner of A-level Mathematics, I have experienced, time and time again, an overwhelmingly high proportion of exam submissions that fail any standards of basic mathematical literacy. Thinking of my role as a Mathematics educator as one of initiating students in mathematical discourse, I have been keen to explore ways in which I could transition my practice from teaching topics in isolation with a focus on method execution to teaching a wider topic as a narrative, going deeper and immersing students in the discourse of that narrative. With this aim in mind, I formulated the following research question.

Action research question

Would exposure to rich mathematical narratives, for example through introducing passages from or equivalent to first year undergraduate textbooks and studying these as part of the coursework, in a scaffolded fashion, have a positive effect on students' overall literacy within a given topic, in particular their written communication skills?

Methodology & design

For the purposes of this project, I worked with a Year 12 Further Mathematics class where I teach the Statistics and Probability strand of the Edexcel A-level course. Statistics and Probability have a distinct literacy that students often find challenging to get to grips with. The type and level of rigorousness of language that is required in written communication is a hybrid of mathematical notation and natural language narrative.

I focused on the topic of Probability, Chapter 5: Probability of the *Pearson Edexcel A-level Mathematics Statistics and Mechanics Year 1/AS* (Attwood et al., 2017a) and Chapter 2: Conditional Probability of the *Pearson Edexcel A-level Mathematics Statistics and Mechanics Year 2* (Attwood et al., 2017b), the content of which was delivered in the space of two teaching weeks in the Lent term 2025.

The main teaching resource and text that we explored in class was Chapter 1: Introduction to Probability Theory of *Introduction to Probability Models* (Ross, 2024). Taking inspiration from the instructional strategies DRTA, GRP and ARC, as outlined on the previous page, I devised five activities (details on request).

To facilitate qualitative analysis of any improvement in written communication skills I devised a rubric (Table 1) to grade student work solely on literacy skills.

Mathematical literacy criteria: Written communication		
C_1	Structure and flow of reasoning	Writes opening and concluding statements as appropriate and shows a necessary and sufficient number of steps for clarity of method
C_2	Communication of the *WHAT*	States what is being calculated e.g. starts every sentence with $P(\text{event}) =$
C_3	Communication of the *HOW*	States formula or rule used to find result, e.g. $P(AUB) = P(A) + P(B) - P(AB)$
C_4	Defines or assigns variables	To support criteria C_1 to C_3, this focuses explicitly on stating e.g. *Let **A** be the event….* as necessary
C_5	Correct use of notation	Correctly using mathematical notation throughout the narrative, including correct annotation of any supporting graphs and diagrams, e.g. probability tree diagrams, Venn diagrams etc.

Table 1: Mathematical literacy criteria

To analyse the effect of the intervention, I marked against these five criteria the following pieces of work:

Baseline task: I assigned this at the beginning of the project, with questions taken from GCSE probability past papers, to both assess students' prior knowledge and their current level of literacy in probability.

Short-term gain task: At the end of the two-week project, I assigned a topic assessment task

Medium-term gain task: At the beginning of the Summer term, students sat their end of year examinations, which included one question on the content of probability relevant to the content covered in this project.

Medium-term transference to applications task: One question of the summer assessment on discrete random variables which was taught immediately after the topic of probability. The above tasks were graded in a scale of 0 to 4 depending on how frequently the quality was observed (never/ rarely/ sometimes/ often/ always).

Results: observations and analysis

Teaching the content from the planned material with a conscious focus on the development of literacy has been both vastly satisfying and very effective in achieving the intended learning outcomes.

The introductory exercises on the concepts and terminology involved in the study of probability allowed for rich discussions, going deeper into the concepts than I had previously experienced and anticipated; the students reacted very positively to exploring the passages, used techniques like underlining, highlighting, comparing and contrasting notes between them in coming to an agreement of what the terms meant and this led to insightful questions being asked, which extended beyond the immediate scope of that lesson, for example, what is the complement of the union or intersection of two events which led to investigating De Morgan's laws.

Immersed in a new literacy style, the students became adept to emulate that of the passages studied following through the notation in the book. Consistent access to literary-rich examples throughout the topic allowed students to appreciate that the teacher's literary approach is neither unique nor exaggerated, but the commonly used way of communicating in this discipline hence reinforcing the expectation that they should develop their literacy skills to produce such narratives (Figure 1).

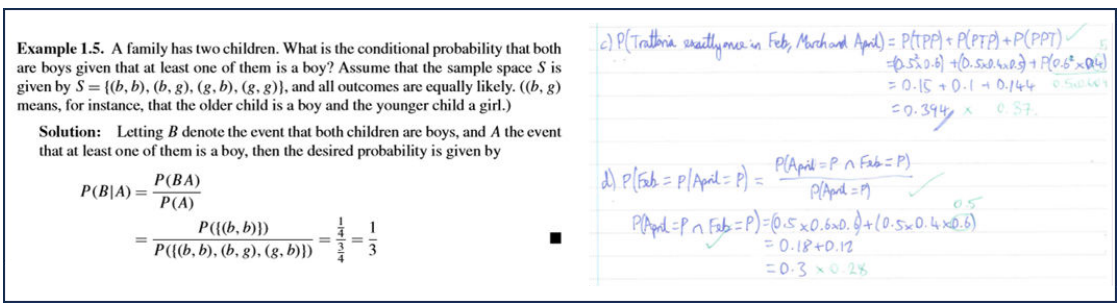

Figure 1: Communicating mathematically (left) passage from (Ross, 2024) and (right) a student's work at the Probability Topic Assessment

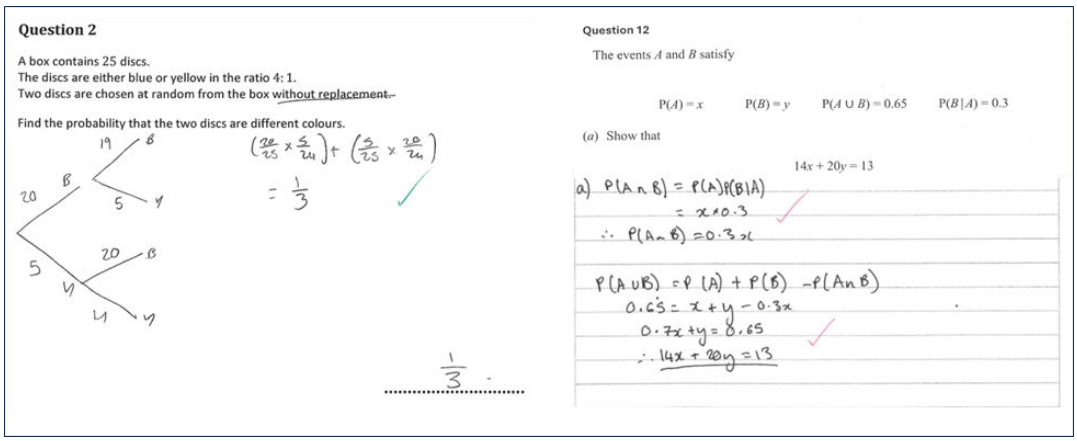

Figure 2: Comparison of a student's literacy in criteria C2 and C3. Extract from baseline task (left) versus the summer assessment probability question (right)

Most of the class started from a strong point in terms of structuring their work in a logical sequence of events and using correct notation throughout (criteria C_1 and C_5, respectively). All students in this class had achieved a 9 at their GCSE Mathematics qualification in June 2024 hence having comparable level of understanding and fluency in many topics covered at GCSE level. At the baseline task the class scored an average of 3 out of 4 and 4 out of 4 in criteria C_1 and C_5, respectively. The example of work shown in Figure 2 is representative of the class's literacy skills at the beginning of this project.

As shown in Figure 3, students' major development has been in criteria C_2 and C_3, communicating what is being calculated and how, by stating the appropriate rule before substituting in values, as per the examples in Figures 1 and 2. Even though significant improvement was observed even in the space of two teaching weeks from the baseline assessment to the topic assessment homework, it is notable that further reinforcement of good literacy practice through continued exposure to the teacher's literacy practice and conscious instruction and feedback past the end of the action research project contributed to the further development of these skills as measured at the summer assessment questions.

Criterion C_4, assigning variables where appropriate, was not applicable in the exercises of the baseline and exam assessment questions, however, it was applicable on the topic assessment. The average improvement in criteria C_2 and C_3 between the baseline and the topic assessment were 1.6 points and 2 points, respectively (Figure 4). The average score on criterion C_4 was 1.6. It is notable that students who scored highly in C_4 were also the ones that improved the most in C_2 and C_3 (See Appendix 3, Figure 6), whereas none of the students with no improvement in literacy between these instances scored any points for C_4. Most of the questions practised from the textbook did not require students to assign variables, however, developing this literacy skill is important in the context of the Further Statistics course in the study of probability distributions and their applications. In the context of this research, students had plenty of access to the concept through the examples in the passages studied, like the one shown in Figure 1 and at further practice questions provided.

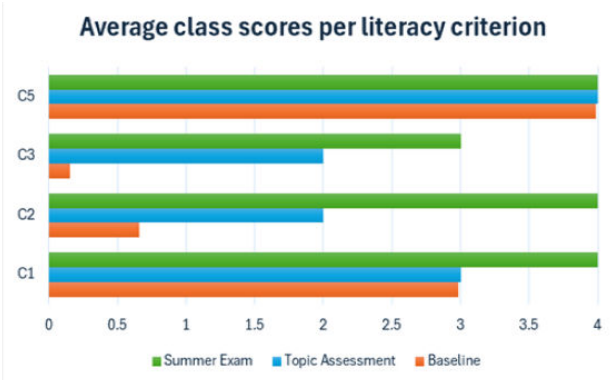

Figure 3. Average class scores on literacy criteria C_1, C_2, C_3 and C_5 across the three assessments, baseline, topic assessment, and summer exam.

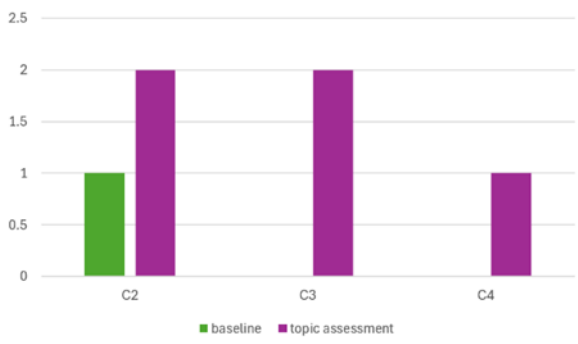

Figure 4. Average class literacy scores at criteria 2, 3 and 4 at the baseline and topic assessments.

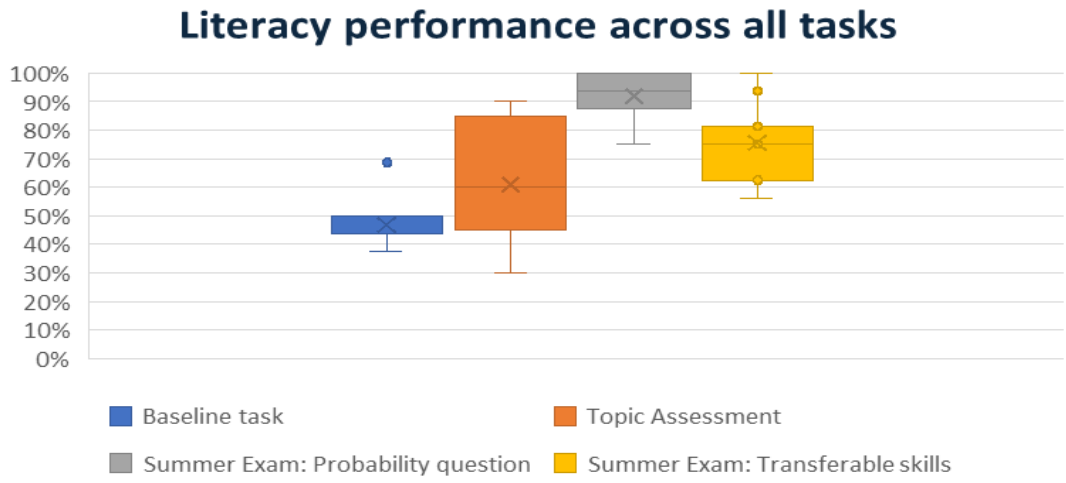

Figure 5. Literacy performance box plots

Figure 5 summarises the results on literacy performance across all four tasks. It is evident that the specific two-week intervention and the consistent conscious focus on literacy throughout the rest of the term have been quite effective in developing students' overall literacy in these topics. Improving literacy, as with all learning, is a process that takes time and practice.

Notably, most students did not score as highly in the discrete random variables (transferability of literacy skills assessment) as in the core probability one. This was the last question on a two-hour paper and many students were short for time, so there is an element of rushing their work in that question to 'get the points in'. It does go to show though, that for skills to embed and to transfer it will require longer practice and refinement with continued effort from my part instructionally, and continued exposure to rich literature relevant to the rest of the course content.

Finally, it is noteworthy that high literacy scores do not guarantee high grade in the exam questions but certainly set the student up as positively as possible to score all points available to them. On the other hand, students scored highly, often full marks, in the transferable skills question of the summer assessment even in the absence of high literacy scores. This is quite telling for the standards on literacy currently endorsed by examination bodies and resulting struggle professionals face when trying to develop 'the whole mathematician' as a lack of expectation can create an environment of laxed approaches to literacy.

Conclusion

In this project, I set out to explore how I could create opportunities in the classroom for the development of mathematical discourse, in the context of Probability and its applications to Statistics. A conscious focus on developing literacy skills, through my own role modelling and through exposure to rich literature relevant to the topics covered, has been very effective in this regard.

A-level Mathematics textbooks for the Edexcel board are often utilitarian in nature, with a focus mainly in the development of skills and processes. Little is given in terms of why a method works and there is often a lack of narrative or thread in linking chapters together. Hence, if used as the sole type of literature a student is exposed to, they can be limiting to initiating learners in the discourse of Mathematics. On the other hand, mark schemes routinely allow for all sorts of discrepancies in literacy skills hence lowering the expectations of literacy levels required to achieve a high grade at A-level. If literacy is truly valued, then, clearly, we need to collectively rethink where we set the bar and how we transition our students from 'casual' mathematicians of everyday life at GCSE level to the 'expert' mathematicians that will take all STEM subjects relying on Mathematics and its applications to the next level.

It is my firm conviction that in the era of AI, 'skilled workforce' will no longer be those that know *how to do*, but those that know *how to think*. We need to be training the next generation how to *be* a mathematician. In Bullock's words "…the role of the scholar is not technical dexterity, but insight" (Bullock, 1994).

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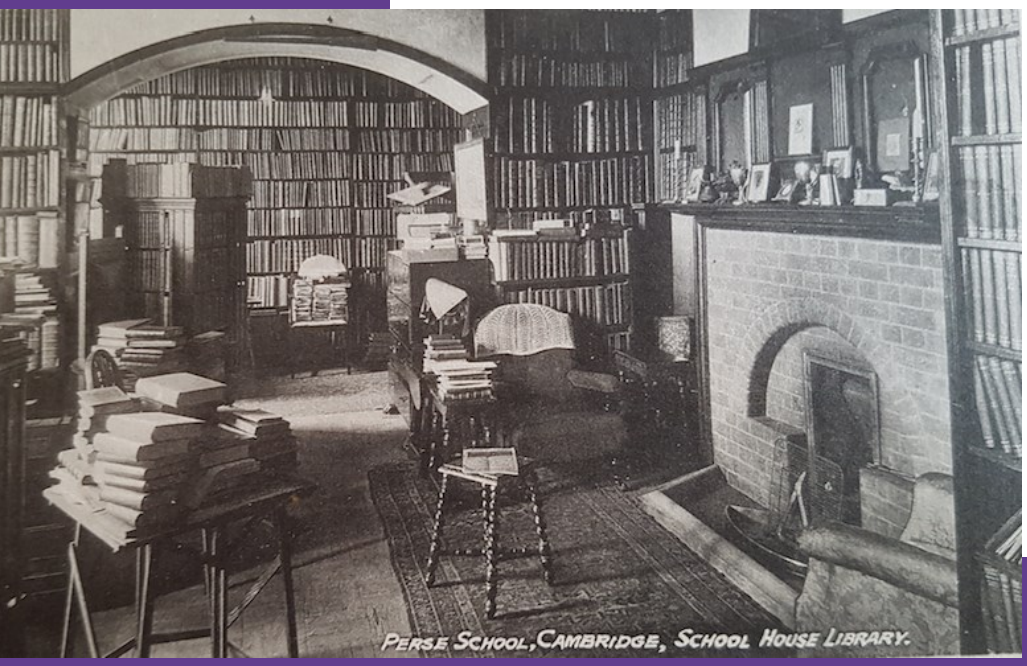


AFTERWORD

'Disciplinary literacy' emerges from these pages less as an off-the-shelf intervention — yet another pedagogical fad — and more like a broad and fundamental professional challenge: if we are not always convinced that students can express themselves fluently and validly in our subjects, and if we have concerns about their depth of understanding and their capacity to derive meaning and apply knowledge in unfamiliar situations, then what can we do about it? How could a renewed attentiveness to the language of our subjects, to their particular literary and linguistic conventions, help us better to help our students?

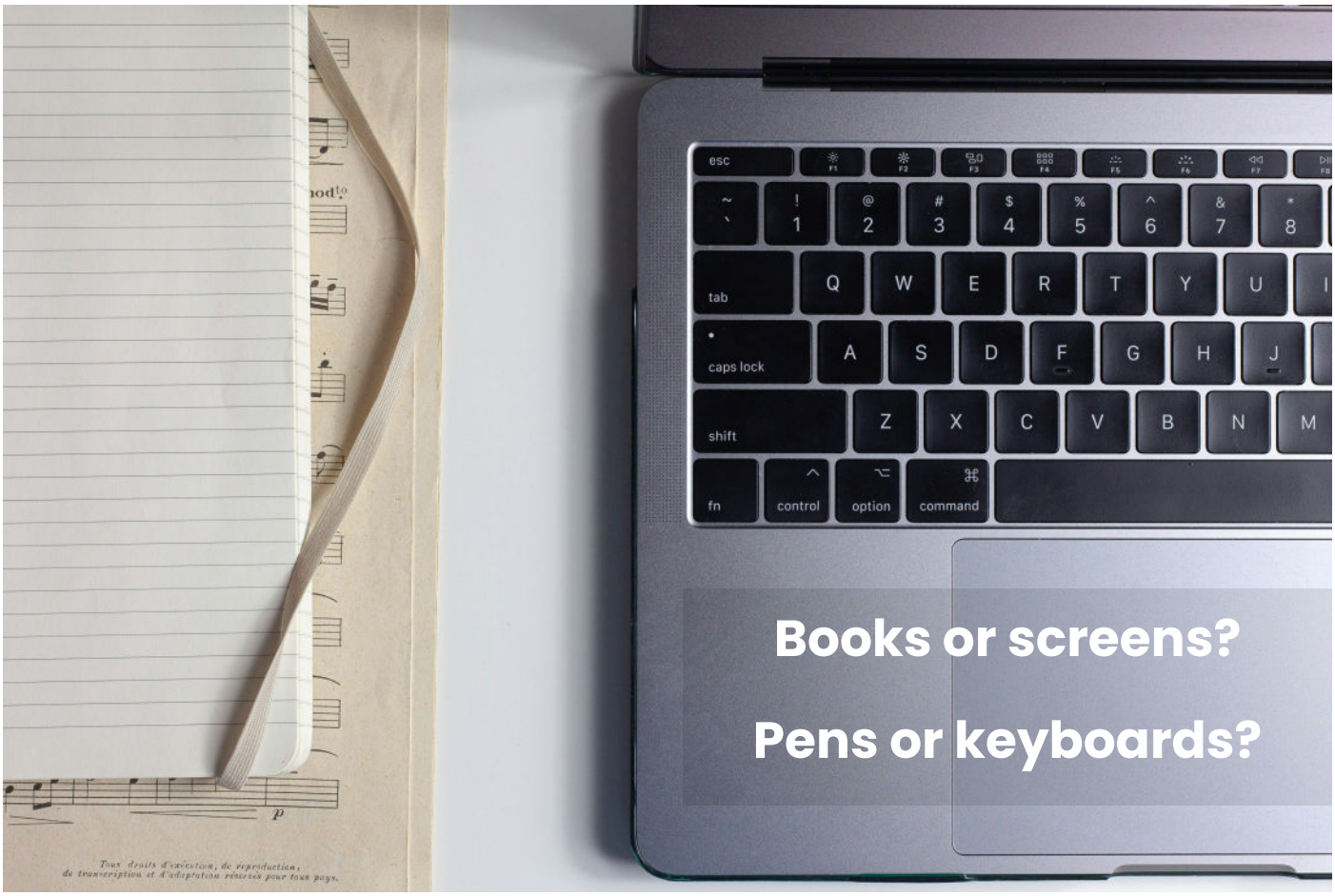
'Literacy' here isn't a matter of placing one's apostrophes correctly; it is about reading, writing, speaking (and, therefore, thinking) like a mathematician, a chemist, a linguist, etc. Enhancing and maintaining the 'literary-richness' of the curriculum (to recycle Eleni Pepona's nice phrase), discipline by discipline, is certainly a challenge — both for us as those who create, teach and assess that curriculum and for the students who are to think and grow through it. But, as this year's Staff Researchers have shown, it is an exciting, and potentially impactful, challenge!

I invite colleagues to consider how 'disciplinary literacy', as reviewed, outlined and trialled so very thoughtfully here, could be applied to stimulate new approaches to reading, writing and speaking in your own subjects. What works? And what doesn't? As Hazel Knight and other contributors reflect, research in this area is far from complete — so please continue the discussion!

And, finally, please do consider participating in the next round of this new style of Perse Staff Research, to develop your expertise and share your insights.

Alexander Courtney, Assistant Head (Teaching and Learning)
September 2025

Looking ahead...



COVID-19 lockdowns pushed schools to make much greater use of digital resources. Now, much of our teaching is based on on-screen resources, all students have devices, and older students are expected to use 'digital workflow' as a matter of course.

Research into the impact of reading from a screen, taking typed notes, or using digital manipulables is mixed and opinions are divided. The 2025-2026 research team will probe further into the existing literature and design practical research into how the use of digital devices affects learning at The Perse.

Applications for the team close in October. Six funded places are available for staff from the Pelican, Prep and Upper on a roughly proportionate basis. Teachers may also join the team to complete research with a view to completing threshold 3.

Please contact Hazel Knight for further details.



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