TEACHING PRACTICES FOR INITIATING AND SUSTAINING CLASSROOM DIALOGUE ABOUT TEXT AND LANGUAGE WITHIN SENIOR HIGH-SCHOOL SCIENCE

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Abstract

Making appropriate language choices to represent meaning about sequences of activity in sequential explanations is essential for success in senior high school biology classrooms, but the ways in which teachers can engage students in classroom dialogue that includes opportunities for the development of this language and associated textual understanding has not been investigated. Design-based research supported two biology teachers in two Australian high schools to learn about the language patterns in English required to represent meanings about activity in senior high school biology and to develop practices that engaged students in classroom dialogue that assisted the learning of the discipline-specific language and associated texts. Through iterative cycles of planning and classroom implementation, the teachers and researchers co-designed practices for involving students in classroom dialogue that made explicit the language of the discipline, began to develop a metalanguage and supported students to reason about their creation of texts and language choices in the disciplinary context. Analyses of transcripts taken from videos of classroom dialogue allowed for the identification of the teaching practices that effectively involved students in dialogue about language and text. Practices associated with text comparison and contrast were most effective for generating classroom dialogue for language learning in biology.

Keywords: genre pedagogy; dialogic pedagogy; metalinguistic; language across the curriculum

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1. INTRODUCTION

Levels of achievement and participation in school-based disciplines, such as biology, depend partly on the linguistic capital that students bring to the learning (Christie, 2012; Rose & Martin, 2012). Students who bring with them knowledge of language and text that closely aligns with the 'linguistic expectations' of school subjects are more likely to succeed than those whose linguistic repertoire is less like the linguistic requirements required by school curricula (Schleppegrell, 2024, p.1). Each subject involves specific text types and language patterns, within the language of instruction, that need to be used effectively by students to express meaning successfully in the disciplinary context (Christie, 2012; Rose & Martin, 2012; Moje, 2015). Students from certain cultural and social backgrounds tend to have less of the linguistic capital that is valued within the restricted official curriculum of schooling (Bourdieu & Passeron, 1990; Christie, 2012), and they can struggle to succeed if they are not apprenticed carefully into the disciplinary specific literacies (Moje, 2015; Rose & Martin, 2012; Schleppegrell, 2004, 2024). As students progress through the school curriculum, the linguistic demands of curricula increase (Christie, 2012; Rose & Martin, 2012). The language of science, in particular, becomes far removed from the everyday and is increasingly technical with complex language patterns and related texts for the expression of precise scientific concepts and succinct summaries of detailed activities (Martin, 2017).

Since the 1990s, genre studies have revealed many of the text types and language patterns that students need to master if they are to be successful within school-based disciplinary contexts. There is especially rich research into the language choices students need to make to express scientific concepts successfully when the language of instruction is English (eg Fang, 2005; Hao, 2020; Martin, 1993a, b; Martin & Rose, 2008). One of the ways in which the language of science becomes more technical across the school years is through the use of nominalisation to identify specific activity sequences. A noun, such as 'transcription', is used to identify and name complex sequences of activity that involve numerous entities and associated actions (Martin, 1993a,c; Martin, 2013). Students then need to be able to use identifying clauses (such as 'transcription is the process'), to define the named activity sequence, and a number of clauses in sequence that step out the specific moments within the activity sequence (Doran & Martin, 2021; Hao, 2020, 2021). For example, the introductory sentence '[t]ranscription is the process by which DNA is copied in the form of mRNA' uses the nominalisation 'transcription' to identify the activity sequence that will be described, and then includes an identifying clause to define the activity sequence. The next sentence '[f]irstly, RNA polymerase attaches to the promoter located on a gene in an anti-sense strand' is then the first clause in a sequence of clauses that steps out the specific moments in the activity sequence. Within each clause, precise noun groups are used to name and classify the types of entities involved in each activity, along with specific verbs for identifying the kind of process the entity is undertaking (Halliday, 1993a; Hao, 2020). In the previous example the

noun group 'RNA polymerase' identifies the entity involved in the activity and classifies the polymerase as the 'RNA' type. The verb 'attaches' immediately follows the entity to be clear about the kind of activity the entity is involved in. Each clause also usually contains adverbs and prepositional phrases to express meanings about the specific circumstances in which the activities take place (Hao, 2020). In the previous example, the prepositional phrase 'in an anti-sense strand' provides information about where the gene is located. Through the use of these language patterns, students can successfully express the concepts of a particular activity sequence within the sequential explanation genre.

While studies into the genres of schooling have revealed the complexities of the text and language that students need to be able to use to be successful, the pedagogies that support students to make appropriate language choices for the disciplinary context are much less researched. The research presented in this article sought to help fill this gap by demonstrating how a focus on dialogic practices, as part of genre pedagogy, can support students to make appropriate language choices and to reason about their selection of language within the disciplinary context of biology.

Past studies of genre pedagogy largely focus on the teacher being explicit about text types and language patterns. Within this pedagogical model, the teacher is the more knowledgeable other who is making explicit for students the texts and language patterns required to be successful within the disciplinary context (Lo & Jeong, 2018; Lo, Lin & Cheung, 2018; Rose & Martin, 2012; Rothery, 1996; Schleppegrell, 2004; Williams & Hasan, 1996). To make the language and text type explicit, the teacher will usually work through the genre teaching and learning cycle, first modelling the genre in its cultural context and deconstructing it by pointing out key language patterns (Christie, 2012; Dreyfus et al., 2016; Lo & Jeong, 2018; Macnaught et al., 2013; Rose & Martin, 2012; Rothery, 1996; Schlepegrell, 2004). Then the teacher continues to be explicit about the language required as they jointly construct a text with the students (Christie, 2012; Dreyfus et al., 2016; Lo & Jeong, 2018; Macnaught et al., 2013; Rose & Martin, 2012; Rothery, 1996). Students then move on to creating their own texts independently (Christie, 2012; Dreyfus et al., 2016; Macnaught et al., 2013; Rose & Martin, 2012; Rothery, 1996).

During the explicit teaching of language, the teacher is both modelling the language use within the disciplinary context and also supporting the students to develop a metalanguage. The metalanguage taught by the teacher is a language about language, which enables the students to discuss the language patterns being used within a genre (Christie, 2012; Dreyfus et al., 2016; Gebhard, 2019; Macnaught et al., 2013; Rose & Martin, 2012; Rothery, 1996; Williams & Hasan, 1996). For example, within the disciplinary context of science, the teacher discusses the prevalence of noun groups containing classifiers that identify types of entities (eg amino acids). Use of language to name language features and patterns of language within a genre is part of the teacher's focus during the genre teaching and learning cycle (Christie, 2012; Dreyfus et al., 2016; Gebhard, 2019; Macnaught et al., 2013; Rose & Martin, 2012; Rothery, 1996).

The emphasis on the teacher's role in the explicit teaching of language in past research about genre pedagogy has resulted in the perception that pedagogy for the teaching of genre and language is teacher centred, focused on transmission of knowledge and authoritarian in manner (Christie, 2013; Kindenberg, 2021; Prain & Tytler, 2013; Rosen, 2013). Genre pedagogy has also been criticised for teaching about language and text in a formulaic way that does not promote students' reasoning about language choices and consideration of how genres may change in subtle ways according to the specific conditions in which they are being produced (Christie, 2013; Kindenberg, 2021; Rosen, 2013). In contrast to these perceptions, early writing about genre pedagogy has valued pedagogy that is dialogic in nature, where students are invited to reason about the effects of particular language features on the purposes of texts within specific contexts (Rose & Martin, 2012). However, a form of genre pedagogy that supports student engagement in dialogue and reasoning about language choice is underdeveloped and has become lost within the many studies with an emphasis on teacher explicitness within pedagogy.

Early writing on genre pedagogy used the theory of Vygotsky (1962) to connect language learning with classroom talk (Rose & Martin, 2012). Vygotsky's (1962) work emphasised the importance of social interactions for learning. Carefully designed dialogic interactions could engage students in meaningful language use. Vygotsky (1962) believed that it was through such language use that students could build understanding of key concepts. Knowledge building could not be separated from language learning and it was through dialogue that language use and conceptual understanding developed. Rose and Martin (2012) made the connection to Vygotsky's (1962) theory and its emphasis on social interaction for language and concept learning. Other early theoretical influences on genre theory also emphasised the role of social interaction in language learning. Halliday (2014) argued that children learn language and use language to make meaning through social interactions. Similarly, Painter (2005), demonstrated how young children develop language through interactions with others. While the importance of dialogue in language learning has influenced the development of genre theory, the notion of explicit and purposeful language use has been dominant in research and the way in which this is generated during classroom talk has not been a focus. The lack of attention to oral language within dialogic interactions is especially prevalent in classrooms beyond the early years and into secondary schooling (Weekes, 2022).

Recent research has begun to explore how explicitness about language can become part of a dialogic pedagogy and allow for student agency in language choices. The emerging work by Myhill and colleagues (2016, 2020, 2022) indicates that effective dialogue about language in the discipline area of English may be achieved if reasoning about language choices is the learning goal. Learning improves when teachers focus classroom talk on a specific purpose and invite upper-primary students to elaborate on and justify their language choices in English classrooms (Myhill et al., 2016). Gibbons (2018) reports that primary school students with English as an additional language can engage in dialogue about disciplinary specific language choices in

science when the teacher recasts students' responses to highlight more appropriate academic language, uses prompts that help students to reword and expand, and puts language of written text into everyday language. Rose (2011, 2018a, b, 2023) indicates that meaningful dialogue about genre can be generated when the teacher focuses students' attention on a particular part of a text, prepares the student by pointing out what to look for, and offers evaluation and elaboration in response to students' input. Edwards-Groves and Davidson (2017), in a study of the influence of dialogic pedagogy on learning and participation in primary schools, found that, when given the opportunity, students could initiate and manage dialogue to extend vocabulary meanings and knowledge. Jones and Chen (2016) examined the talk moves primary teachers make when generating dialogue about language choices at the clause level. They found that teacher talk dominates when new concepts about grammar are introduced, but that there is more opportunity for teachers to extend students' responses when students' knowledge of grammar grows.

Findings from these predominantly primary English-focused studies suggest that dialogic pedagogy has potential for further application and development in disciplinary literacy learning, but what this means for supporting science learning in secondary classrooms remains largely unexplored. Previous studies that do examine the use of genre pedagogy in high school classrooms do not include dialogic teaching practices and focus on how partnership with university-based linguists support the use of resources for the explicit teaching of language. Lo and Jeong (2018) recount how a humanities class in Hong Kong, where the language of instruction is English, learnt about the structure and language of argumentative essays through a powerpoint that explicitly deconstructed the stages of the essay and the key language patterns. The researchers also worked with science teachers working in year 8 in a Hong Kong high school and provided resources that supported the teachers to deconstruct sequential explanations and be explicit about subject-specific words and their connection to specific verbs. While these two recent studies demonstrate that explicit teaching of the structure and language of genres in high school classrooms can support students to write appropriately in English in humanities and science high-school classrooms, the generation of a dialogic pedagogy, with a focus on reasoning about text and language, has not been a focus in the research.

This study provides detailed case studies of two teachers working in senior high-school classrooms to build a dialogic pedagogy for learning and reasoning about text and language in science. Both teachers were invited to consider teaching practices that generate classroom dialogue where students make language choices appropriate for the disciplinary context, begin to develop a metalanguage and reason about their language use. The research question guiding the work of the teachers in their classrooms was 'What teaching practices generate classroom dialogue that enable students to use language appropriately for expressing key ideas, develop a language to talk about language and allow students to reason about texts and language in the disciplinary context of science?'

2. METHODOLOGY

The methodology used for this study was design-based research. Such research involves iterative cycles of planning and implementation with teachers. Researchers and teachers build theory and practice together as they undertake cycles of intervention within classrooms (Anderson & Shattuck, 2012; Barab & Squire, 2004; Collins et al., 2004). Over three years, biology teachers in four Australian urban high schools worked with the researchers to investigate teaching practices that engage students in dialogue that supports use of appropriate language for the disciplinary context, builds metalanguage and provides opportunities for students to reason about language choices in context. The research work with the biology teachers was part of a larger project that also involved researchers working with chemistry and physics teachers to explore pedagogies for learning about language and text in disciplinary contexts. The researchers working with groups of teachers in the project had backgrounds in genre theory and pedagogy. The data reported in this paper focuses on the research conducted with two of the biology teachers.

The teachers involved in the project had freedom to develop teaching practices that they thought would engage students in classroom talk that included purposeful and reasoned language use. Initial input from the researchers involved an introduction to the key idea that conceptual learning in any disciplinary context could not occur without learning about and using the language for expressing these concepts. The researchers explained to the teachers that generating opportunities for students to use and reason about the language of science within classroom talk was a key goal, and they invited the teachers to explore ways of doing this in their classrooms. The researchers also shared the genre teaching and learning cycle with the teachers and explained how there could be opportunities for students to engage in disciplinary language use during classroom talk as texts were deconstructed, jointly constructed and independently constructed. The researchers encouraged the teachers to see the genre teaching and learning cycle not as a set sequence of practice, that had to occur in a certain order, but as a way to bring discipline-relevant texts into the classroom and to engage students in discussions of the texts, their purposes and their related language patterns.

Most of the science teachers involved in the project had little knowledge about language and how it worked to realise key meanings in science. To support the teachers to develop their understanding of genre theory and knowledge about language, the project began by inviting the teachers to collect texts that students had generated independently for assessment purposes in senior high-school biology. Students created the texts in response to a short answer practice examination question under test conditions. The task required that students write activity sequences for transcription (making a copy of a gene's DNA sequence) and translation (making a protein from the copy of a gene's DNA sequence). The researchers then used the literature from genre theory on language for expressing meaning about activity in science to analyse texts that the teachers had rated as 'excellent' or 'good'. The analyses

determined the language conventions required by students in the last year of high school to present knowledge about activity sequences effectively in biology. The researchers then shared the key language conventions that emerged from the analyses, as a way to build the teachers' knowledge of language for expressing conceptual meanings in biology. Table 1 summarises the language features and their key purposes that the researchers shared with the teachers. The table also provides the literature that the researchers used to support analysis of the student texts.

Table 1. Analytical framework for the language required to realise meanings within activity sequences

Meaning created within the text	Language convention with example	Research related to the language convention
Sequenced activities that entities are involved in	• Nominalisation used to name a pattern of activities (e.g. transcription)	• Halliday, 1993b; Hao, 2020; Martin, 1993a
	• Activity entity defined through an identifying clause (e.g. Transcription is the process by which DNA is copied in the form of mRNA)	• Halliday, 1993b; Hao, 2020; Martin, 1993a, c
	• Noun groups with classifiers are used to identify key entities in the activity sequence (e.g. amino acid)	• Halliday, 1993b; Hao, 2020; Martin, 1993c
	• Noun groups with qualifiers are used to depict key entities and their parts (e.g. the nucleus of the cell)	• Martin, 1993a; Martin & Rose, 2008
	• Number of event figures are used in sequence to depict moments in the activity sequence	• Hao, 2020, 2021; Doran & Martin, 2021
	• Material processes place participants in relationship with specific activity (e.g. detaches)	• Halliday, 1993b; Hao, 2020; Martin, 1993c
	• Circumstances within the noun group and clause (e.g. from the ribosome)	• Halliday, 1993b; Hao, 2020
	• External conjunctions (particularly temporal successive) used between clauses to relate activities (e.g. next)	• Hao, 2020; Martin 1993a; Martin & Rose, 2008
	• External conjunctions used between clauses to relate activities are explicit or implicit	• Martin 1993a; Martin & Rose, 2008

The process of building knowledge about language and text through analysis of current student assessments effectively engaged the teachers in learning about the language patterns that their students needed to master to be successful students in senior biology.

In each year of the project, the teachers chose lessons that they wanted videoed by the research team. The teachers were asked to choose lessons that showcased their evolving practices for engaging students in classroom dialogue about texts and language. Transcripts were made of the classroom talk that evolved during these recorded lessons. The researchers then analysed the transcripts and shared the analyses with the teachers. Further analysis occurred as the researchers and teachers discussed the classroom dialogue. The analyses and discussion of these then informed the planning work that the teachers did for the next cycle of implementation.

The framework used in the project for the analysis of the transcripts of classroom dialogue evolved over time. The initial framework was informed by the two researchers in genre pedagogy, Gibbons (1998, 2003, 2008, 2018) and Rose (2011, 2018a, 2018b, 2021, 2023), who have provided some insights into how teachers can generate dialogue about text and language. The work of Gibbons and Rose provided the teacher practices of focusing student attention on part of a text, converting to everyday language, elaborating on student responses, by recasting to more appropriate language, and prompting students to reword their responses. As the teachers and researchers discussed the video data from each cycle of implementation each year, the framework was revised and added to. The final framework for analysing the classroom dialogue is presented here and was used to analyse the two episodes of classroom talk included in this paper.

The framework for analysing classroom talk that evolved across the project involved examining the content of the students' input into the dialogue, as well as the teaching practices used to engage the students and to elicit specific types of input from them. One level of analysis focused on the content of the students' inputs and involved looking at if the students:

- explicitly used appropriate language features for expressing key ideas related to the topic;
- began to develop a metalanguage for talking about language;
- reasoned about text and language.

The other level of analysis looked at the teaching practices that supported the different kinds of student inputs into the classroom dialogue. The list of teaching practices that were applied to the analysis included the teacher:

- using deconstruction, joint construction and/or independent construction of texts to prompt classroom talk;
- comparing and contrasting texts;
- focusing student attention on a particular part of a text;
- modelling part of a text;
- converting from technical to everyday language;
- converting nominalisations into the verb form;
- providing positive evaluation of a student response;
- taking up the ideas offered by students;
- inviting students to elaborate more;

- elaborating on a student response;
- recasting to more appropriate language;
- inviting an alternative perspective;
- inviting the students to reason about their texts and language use.

The pedagogies used by two of the senior biology teachers in the final year of the project are analysed in this paper. The pedagogies of these two teachers were chosen as they were among the best examples of evolving practice to emerge from the project. One teacher, Eliza, chose two lessons to be videoed in the final year. One involved her engaging students in a discussion of the language used to name and define the activity sequence of transcription, while the other focused on translation. The other teacher, Parvati chose to video a lesson where she involved students in dialogue about visual representations of transcription and translation. The researchers initially watched the videos and then made transcripts of identified episodes within the lessons that demonstrated practices for the explicit use of language, developing a metalanguage and providing opportunities to reason about text and language. One episode from each of Eliza's 2 filmed lessons and 2 episodes from Parvati's videoed lesson are analysed in this paper.

Pseudonyms for both teachers were applied at the time of data analysis. In both classrooms, English was the language of instruction. Some of the students had English as a first language, while for others in the class English was an additional language. All of the students were in their final year of high school in Australia.

3. RESULTS

The classroom dialogue that the 2 teachers generated is presented for each scenario alongside the analysis that occurred using the framework of teaching practices. The specific teaching practices used by the teachers are bolded throughout the analysis. Each scenario concludes with a summary of the teaching practices used to support student input into the classroom dialogue.

3.1 Eliza scenario 1

The scenario presented here occurred within the first part of a learning sequence on transcription and translation. The students had covered the content in the year before, but were now beginning to revise and deepen their knowledge in the following year. Eliza first placed the students in groups of 3 in the classroom and projected on to the whiteboard a short text from their textbook: 'When a gene becomes active, it first makes a mobile copy of the coded instruction that it contains. This occurs by a process known as transcription' (Kinnear & Martin, 2016, p.59). Eliza **used this text as an initial prompt for a joint construction activity** that she then initiates with her students. She asks the students in their groups of 3 to use the information to write together a one sentence definition using the stem consisting of a nominalisation and a relational process: 'Transcription is…'. By providing the stem, Eliza is **modelling** for

the students how definitions for activity sequences in biology often begin with a nominalised term that refers to the whole activity followed by a relational process. Eliza then offers an **invitation for the students to reason** about how the purpose of definitions in science is connected to the language used within definitions.

> T: When scientists work like this umm they are, they try to put scientific knowledge very concise and make it precise. They get it concise and precise and they are writing up some scientific information.

Within this context, the students then work in their groups of 3 to write their definitions of transcription.

Eliza then invites each group to share their definition and one student from each of the groups reads their definition out. As they read out the definitions Eliza writes them on the white board:

> S1: Transcription is the process of copying DNA's coded instructions to the mRNA.
>
> S2: Transcription is the process where DNA instructions are copied.
>
> S3: Transcription is when a gene becomes active and the coding strand is copied.
>
> S4: Transcription is when a gene becomes active and the coding strand is copied changing thymine to uracil.
>
> S5: Transcription is the process when it creates a copy of the segment of DNA.

The spokesperson for each group presents a definition that uses the appropriate stem modelled initially by the teacher, 'Transcription is', to make the identifying clause. The students also use language that is relevant for presenting key ideas in the topic. Three of the students share definitions with the class that use the noun group 'the process' to identify transcription as a specific process. Other noun groups with classifiers are used to identify the key entities involved in the activity sequence. For example, the noun group 'the coding strand' identifies the specific type of strand involved in the activity sequence and 'DNA instructions' classifies the kind of instructions involved. Appropriate material processes are expressed to place participants in relationship with a specific activity. For example, the material process 'are copied' identifies what is happening to the 'DNA instructions'. Circumstances are also used to provide more information about where activities are happening (for example 'DNA's coded instructions' are copied 'to the mRNA').

Eliza then **invites the students to compare and contrast the definitions** as a way to reason about which definition is the best.

> T: Which one do you think is a suitable definition?

Multiple students call out their preferences, with no students in the class opting for the fourth definition. Eliza then **invites the students to elaborate** on their reasoning by asking them why they think that the fourth option is not a good definition. One student reasons

> S: Too much irrelevant information.

Eliza then uses **text deconstruction** to break the definitions into parts and to engage the students in dialogue that supports a developing metalanguage. She **focuses the students' attention** on the part of the definitions with the nominalisation 'transcription', names the language as nominalisation and then shows the students how nominalisation works by **converting the term into the verb** 'to transcribe':

> *T*: Ok you have done that so 'transcription' I would say is a nominalised term and do you know what is the meaning of nominalised term? Nominalised terms? Do you know what it is? It comes from the word 'transcribe'.

Eliza then **invites the students to consider more everyday language** for the verb 'transcribe'.

> T: Ok now can you give me any everyday word for the word transcribe? When we say transcribe is there any other everyday language form- where you can give another word or another meaning of transcribe?

One student calls out the synonym 'copy'. Eliza **affirms the student's response**. She **takes up the language offered by the student and elaborates on it** by referring back to one of the definitions on the white board and connects the material process with an entity in the activity sequence.

> T: Copy very good so copy. So that is what here some of you mentioned copying DNA's coded instruction.

Within this first scenario, Eliza first uses joint construction, along with the modelling of how to use language to express a definition for an activity sequence, to generate classroom talk. The sharing of the jointly constructed definitions results in students using appropriate language explicitly to express key ideas for the topic of transcription. Eliza's practice of then asking the students to compare and contrast their definitions invites the students to reason about the nature of definitions in science. She then invites them to elaborate on their reasoning and this leads to a student concluding that scientific definitions need to be concise. Eliza then focuses the students' attention on parts of their shared definitions and this results in classroom dialogue about metalanguage. Focusing on the nominalised term 'transcription' and converting this to the verb form supports student understanding of how nominalisation works in scientific explanations and enables the students to convert technical language to everyday language. Eliza then affirms student input in the classroom talk, takes up their idea and elaborates on it by demonstrating how the everyday verb 'copy' is used in the definitions to describe the actions of key entities in the activity sequence.

3.2 Eliza scenario 2

In a lesson later in the learning sequence, when transcription had been covered, Eliza engages the students in dialogue about an appropriate definition for the activity sequence of translation. She uses **joint construction of text with the students to**

prompt the classroom talk. Eliza **models** on the whiteboard the stem for the identifying clause 'Translation is the process…' One student then volunteers to come to the whiteboard to write the rest of the definition. She writes 'in which genetic instructions are decoded and translated into a protein chain built of amino acids'.

Eliza then writes an alternative definition for translation on the whiteboard: 'Translation is the process in which the genetic information on mRNA is decoded and translated to a protein chain in the cytoplasm'. She then **invites the students to compare and contrast the two definitions:**

> T: So what is the difference between these two definitions? What have you seen?

One student reasons that the second definition is different because it contains additional information about mRNA:

> S1: You refer to mRNA.

Eliza **takes up the student's idea, elaborates on it and invites the students to reason further** about the differences between the two definitions:

> T: So we refer to mRNA the type yeah and then what else?

Within the elaboration, the teacher supports the students to consider the metalanguage. She indicates that the abbreviated noun group 'mRNA' is providing information about type. In response to Eliza's invitation for the students to reason further about the differences between the definitions, one student explains that further circumstantial information is also included in the second definition:

> S2: Where it takes place.

Eliza **takes up the student's response, affirms it and recasts to use the technical language** of 'the cytoplasm':

> T: Where it takes place very good. So it is in the cytoplasm.

Eliza then **elaborates on the students' reasoning** about the differences between the two definitions by inviting the students to consider how the second definition has been expressed more concisely by taking information about the amino acids out and capturing this information in the noun group 'protein chain':

> T: And we normally say translated into a protein chain so protein chains is we all know the protein chain is made up of amino acids isn't it. So instead of repeating it in two places if we just write a protein chain but we say where it is taking place that would be more detail.

Eliza's elaboration and invitation to reason further about the differences between the definitions supports the students to connect the language choices with the disciplinary context of science. Eliza **elaborates** that scientific writing, especially definitions, are concise, without repetition and with essential meanings, such as where an activity is taking place. She also **focuses attention** on the use of the noun group 'protein chain'.

A student then elaborates on Eliza's point about the use of this noun group and asks a clarifying question about the noun group:

S2: Miss can we say polypeptide chain instead of protein?

In the question, the student is recasting to use more technical language explicitly and demonstrating understanding of how to use the noun group to classify types of entities. The student is also reasoning about the language choices being made. Eliza **affirms the student's response, takes up their use of the noun group 'polypeptide chain' and confirms the student's reasoning** that the 'polypeptide' and 'protein' have the same meaning:

T: Yes you can also say polypeptide chain because protein means a polypeptide chain.

Within this second scenario, Eliza also begins with joint construction. She models the stem of an identifying clause for expressing definitions in science and invites a student to complete the definition that she has begun. Eliza then offers an alternative definition and invites the students to compare and contrast the two definitions. A student offers some reasoning about how the two texts differ and Eliza takes up the student's idea, elaborates on it and invites further reasoning. Through these practices, Eliza supports the students to consider the metalanguage involved and to reason further about the nature of definitions in science. A student provides further reasoning about how one definition contains circumstantial information and Eliza takes up the idea, affirms it and recasts to more technical language. Eliza then elaborates further on the students' reasoning about the differences between the definitions and focuses in on the use of the noun group 'protein chain'. This supports a student to recast to the more technical language of 'polypeptide chain' and to reason about the appropriateness of the noun groups being used within the definition to identify key entities.

3.3 Parvati scenario 1

Parvati moved flexibly between independent construction, deconstruction and joint construction constantly as she engaged her students in language rich dialogue. She aimed within the teaching episode to engage students in dialogue that supported students to use explicit language for expressing meaning about the moments within activity sequences, the names of entities, the material processes entities are engaged in and the circumstances in which the processes occur. She also wanted to facilitate student reasoning about text and language for representing the activity sequences for transcription and translation.

At the beginning of the topic, the students had completed a task where they wrote sequential explanations for transcription and translation and also included visual representations for the activity sequences. These initial texts were based on what the students remembered from the topic when it was covered in the previous year. Then, at the end of the topic, Parvati asked the students to redo their written and

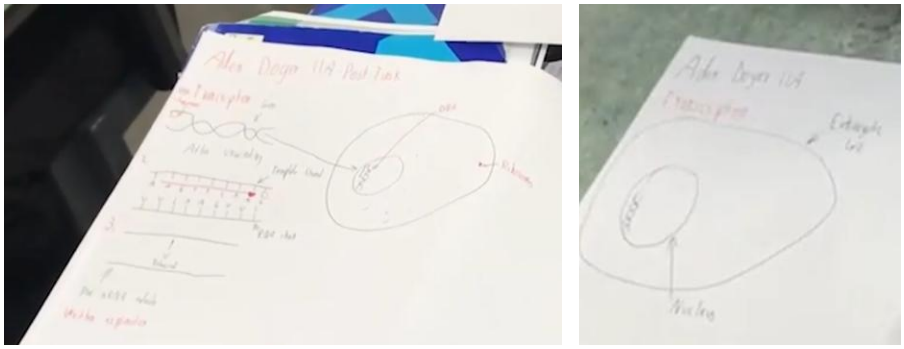
visual texts, with the requirement that they add much more detail into the activity sequences.

As the students work on their revised visual representations, the teacher moves around the room and uses the students' initial visual representation, alongside the one they are now working on, to engage each individual student in dialogue about their texts. The analysis presented here is based on the dialogue between Parvati and two of the students in the class. The interactions are occurring in the same lesson.

Parvati goes to where a student is working independently on their revised text. She puts the student's original labelled drawing alongside the one that they are now working on. She then invites the student **to focus on the first part of each visual representation and asks him to compare and contrast them**. Through this invitation, Parvati is also **inviting the student to reason about how they are representing visually the activity sequence**:

> T: Can you just go through the diagram—how is this one different to this one? How you started? Can you talk me through your diagram?

Figure 1. The two visual representations that Parvati and the student are focusing on in the dialogue



The student considers the beginnings of the two visual representations and begins to reason about how they are creating the texts:

> S: Well how I am starting is pretty much the same but (the student hesitates).

The teacher then **invites the students to elaborate on their reasoning**:

> T: How? What are you trying to show me here?

The student responds and provides further reasoning about their text. He points to the initial diagram:

> S: Well in the beginning I am just trying to show an overview of the cell and then afterwards (now pointing to the diagram they are working on) I am going to focus in on the DNA.

In his response, the student reasons that they have begun the visual representation with the big picture of the 'overview of the cell' and that they will then structure the text by providing a focus on one element of the cell, 'the DNA'. As well as reasoning about the text structure, the student is using explicitly noun groups that identify the key entities in the topic: 'the cell' and 'the DNA'.

The teacher then **invites the student to elaborate further** with their reasoning about the structure of the visual representation:

T: Why DNA?

The student provides their reasoning for having the DNA as the next part of the text:

S: Because that is where the transcription takes place.

In their response, the student explains that where activities are happening is an important part of sequential explanations. He also uses the technical nominalisation 'transcription' to name the activity sequence.

The teacher then **invites the student to reason further** about their visual representation. She **focuses on the nucleus** of the cell that the student has drawn and at this point she is beginning to jointly construct the second diagram with the student:

T: All right. So the transcription takes place inside?

By doing this, the teacher is asking the student to think about where the DNA is located within their visual representation. The student affirms that the DNA they will focus on in the next stage of the diagram is located in the nucleus of the cell that they have drawn:

S: Yeah.

The teacher then i**nvites the student to use language explicitly to name the specific part of the cell**. She **focuses** again on the nucleus of the cell that the student has drawn:

T: What is that?

The student then uses the correct noun group to name specifically the entity:

S: The nucleus.

The teacher **affirms their use of the noun group to name the entity and then invites the student to reason again** about the structure of their visual representation:

T: The nucleus good. That is why you are starting with the cell?

The student affirms their decision to start the representation of the activity sequence with the cell:

S: Yeah.

The teacher **affirms the student's response and then asks him to reason further** on how he will depict the activity sequence in the rest of is text. To do this, she **invites**

the student to compare the second text with the first one he created at the beginning of the topic:

> T: Right. And what next? How can you refine this diagram? I can see that you (the teacher points to the student's original drawing) started this one as well here with the cell.

The student provides a reasoned conclusion about why they are doing the second text differently from the first. They explain how depicting specific moments of activity and where these activities are happening is important in the text:

> S: Mmm. Ah. So I sort of tried to make it a bit more kind of clear about what is happening because it is kind of unclear about what is happening (the student points to their original drawing) and where it is happening.

The teacher **affirms the student's response** and this encourages the student to continue.

> T: Yes.
>
> S: So I want to add maybe a few more visual indicators as to what is happening and what is doing it.

The student reasons that their first attempt did not depict enough activities and the entities undertaking these activities. The teacher **affirms the student's reasoning and invites them to focus on** what they will do next in the text they are currently working on:

> T: Good, right, so what goes after this? (The teacher is pointing to the drawing that the student is now working on).

The student reasons that the next part of their visual representation will focus on the key entity that follows the depiction of the DNA, the gene, and is the next specific location in the sequence of activity.

> S: Well next I am going to do the same kind of thing with the-do a zoom in on the gene of the DNA.

Within this response, the student has used a noun group consisting of the entity 'the gene' and the qualifier 'of the DNA' to express the important concept about the entities that the gene is a part of the DNA. The teacher **affirms their response and this invites them to reason** about the next activity and key entities that they will depict in their text:

> *S: And then show the attachment of the polymerase to the promoter and then label it.*

In their response the student uses a complex technical noun group to express the next activity and the entities involved. They nominalise the material process 'to attach' to begin the noun group with 'the attachment'. They then provide the qualifier 'of the polymerase' to make it clear that it is the entity 'the polymerase' involved in the activity of 'attachment'. A circumstantial phrase is then used to indicate where the activity of 'attachment' is taking place: 'to the promoter'.

The teacher **affirms the student's response** and work overall:

T: Ok, good, good.

In this first scenario, Parvati moves fluidly between independent construction, deconstruction and joint construction of text to engage a student in dialogue. She invites the student to compare and contrast their second independently constructed text with their first, and she focuses the student's attention on specific parts of the texts as they do this. As a result, the student reasons about how they are structuring their visual explanations. As the student reasons about their visual representation of the activity sequence, Parvati invites the student to elaborate further. She also extends the student's reasoning about their text by focusing their attention on certain parts. Her use of affirmation throughout also encourages the student to continue his reasoning about the way he is depicting the activity sequence. The student also is supported to use appropriate explicit language to express key concepts for the topic.

3.4 Parvati scenario 2

Parvati moves to another student in the class and engages them in dialogue about the texts they are creating. She puts the student's original labelled drawing alongside the one that they are now working on and **invites the student to contrast them**. The teacher is inviting the student to reason about how they are depicting the visual representations.

T: How is this different from the one that you are doing now?

The student begins his reasoning by identifying the first drawing as the pre task they did at the beginning of the unit of work:

S: That is the pre task.

Figure 2. Image of the pre task that the student is referring to

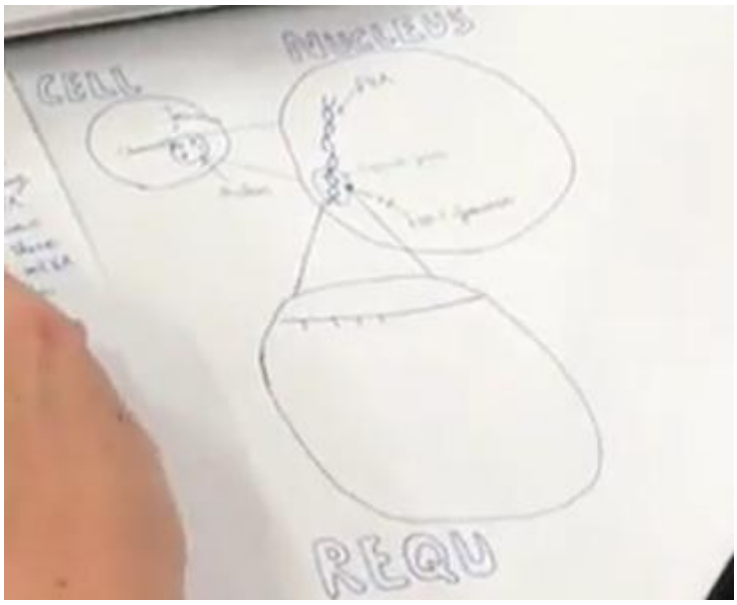
The teacher **affirms this and the affirmation invites further elaboration** of his reasoning:

S: Hmm so. (The student hesitates.)

The teacher notices the student is hesitant and uses the text that the student is currently working on to support his reasoning about how he is creating the visual representation. She **focuses the student's attention on how he began the activity sequence in the second drawing**:

T: So you started with the (the teacher points to the picture of the cell).

Figure 3. The second visual representation that the student is working on



The teacher's focus on a specific part of the text helps the students to begin his reasoning about how the second drawing is different from the first and it also invites the student to use language explicitly in the disciplinary context.

S: So the one that I am doing now, I started with the cell. (The student points to the image of the cell that she has drawn). And then the nucleus. (The student points to the picture of the nucleus with the double helix drawn inside it). And then the specific gene. (The student points to the picture of the gene that is still being drawn). But with the first one I just focused on the whole cell. (The student points to the one image of the cell that makes up the initial drawing).

In the response, the student reasons that a text that visually represents an activity sequence needs to begin with the overview of the cell and then depict each entity involved in the activities in the cell specifically and in the order of the activities. He also uses noun groups relevant for identifying the key entities in the activity sequence: 'the cell', 'the nucleus', 'the specific gene' and 'the whole cell'. As the student is listing the key entities in the order of the activity sequence, he uses an explicit external conjunction to relate the activities in successive time: 'then'.

The teacher **affirms the response** and this encourages the student to continue with their reasoning about the second text that they are creating in contrast with their first:

> T: Good yes.
>
> S: And yeah I guess more focusing on the process of transcription rather than gene expression.

The student reasons that in the first text they represented the concept of transcription at the whole cell level, while in the second drawing they were concentrating more on the moment by moment activities of gene expression. The teacher takes up the idea of the student and elaborates on it by suggesting that in the first drawing he was focusing on the high level of the cell and not the moments in the activity. At this point, the teacher is engaging in dialogue that is jointly constructing the second text with the student. The student affirms that they are focusing on the moments in the activity in the second diagram:

> S: Yeah.

Parvati then **focuses the student on part of their second drawing and invites him to reason** about what exactly will be transcribed in the activity sequence. The teacher is **inviting the student to offer an alternative view**:

> T: Now when you are looking at this section of the DNA. (The teacher points to the depiction of the nucleus with the double helix inside it.) Will the whole section be transcribed?

The student offers an alternative position to what the teacher has presented and indicates where they have shown on their diagram that only the gene will be transcribed:

> S: No so (The student points to the label that they have on their diagram for the specific gene).

Parvati **affirms the student's response and focuses attention** on the same part of the drawing as the student. She **invites the student to elaborate further** about how he is depicting the key entity of the gene in the drawing of the activity sequence:

> T: Ah so you have labelled this the required gene the green one. (The teacher is pointing to the label written in green.)

The student confirms the teacher's interpretation of their drawing:

> S: Yeah, yeah.

The teacher then **affirms** what the student is doing in their second visual representation of the activity sequence and the student continues creating their text:

> T: Yep that's good, that's good. That's excellent.

Within the second scenario, Parvati uses text deconstruction, along with independent and joint text construction, to prompt dialogue with a student. The student is invited to compare and contrast their independently constructed visual representations. Focusing the student's attention on specific parts of texts supports their reasoning about how they are constructing their representations of the activity sequence and also provides opportunities for the student to use explicit appropriate language for the disciplinary context. Parvati's use of affirmation throughout supports the student to elaborate their reasoning about the text creation and to use more explicit language for expressing relevant ideas. Parvati also invites the student to offer an alternative point of view and this supports further reasoning about the way the second independent construction is being structured.

4. DISCUSSION

Both teachers engage students in classroom dialogue that supports the explicit use of appropriate language features for expressing key ideas and invites reasoning about text and language. One teacher, Eliza, also generates classroom talk that engages students in a metalanguage for talking about language. Parvati and Eliza use the genre teaching and learning cycle in fluid ways, along with a range of additional teaching practices, to generate classroom talk that purposefully focuses on language and text. Comparing and contrasting texts emerges for both teachers as an important part of their evolving pedagogy for supporting classroom dialogue that includes purposeful discussion of language and text.

4.1 Using the genre teaching and learning cycle in fluid ways to support classroom talk

When using texts as prompts for classroom dialogue, the teachers move flexibly within the genre teaching and learning cycle. Eliza involves students in the joint construction of definitions for transcription, before deconstructing the definitions to engage the students in a discussion of the metalanguage. She also jointly constructs with a student a definition of translation before moving on to engage the students in an activity that compares and contrasts two definitions. Parvati begins with student independent construction of texts before engaging each student in an activity where they compare and contrast their independently constructed visual texts. The teachers demonstrate that fluid use of the genre teaching and learning cycle can be used to engage students in purposeful classroom dialogue that supports explicit language use of conceptual meanings, the development of a metalanguage and student reasoning about language and text. Most studies of genre pedagogy present the teaching and learning cycle as a sequential formula, with each sequenced step a requirement for the teacher's explicit teaching of language and text (eg Dreyfus et al., 2016; Christie, 2012; Rothery, 1996). The examples presented here indicate that a fluid approach, with elements used out of sequence, is required to support

meaningful classroom dialogue that involves students in explicit language use, as well as reasoning about text construction and language choices.

The teachers use a number of strategies that support the students to engage in dialogue that involves the deconstruction of their texts. Previous studies of genre pedagogy have emphasised the role of the teacher in modelling a genre and then deconstructing it by highlighting for students the structure and language patterns (eg Dreyfus et al 2016; Christie, 2012; Lo & Jeong, 2018; Rose & Martin, 2012). However, in this study, the teachers' practices are designed to generate dialogue with students about texts as they are deconstructed. The teaching practices that evolve in the study aim to support the students to reason about the structure and language of texts and to engage students in dialogue about this. The emphasis on dialogue results in pedagogy that is far removed from the traditional genre pedagogy of deconstructing model texts. Both teachers, at times, focus in on parts of texts and invite the students to consider a specific language pattern or structural element of a text. For example, Parvati invites one student to focus on the beginning of their individually constructed texts and this results in the student describing how he has broken down the second text into the key entities of the cell, the nucleus and the specific gene. Eliza invites students in her class to construct jointly definitions of transcription in small groups before she asks them to deconstruct them by focusing on the use of nominalisation and how to convert these terms to everyday language.

It is when Eliza is asking the students to deconstruct the definitions of transcription that they have produced that she generates dialogue for learning about a metalanguage. During this classroom talk, Eliza explains how 'transcription' is a nominalised term and she asks the students if they understand what this means. She then converts the nominalisation to the verb 'to transcribe' and asks the students to consider a more everyday term for this. During this dialogue, Eliza is beginning to engage the students in classroom talk about a metalanguage and she is asking them to consider how the language in the cultural context of biology is working. The example provided here suggests that the move from joint construction to deconstruction with students can support this kind of dialogue. Generating classroom talk that includes a language for talking about language is certainly challenging for teachers, but Eliza's practice indicates that it can be built into moments of teaching when there is an aim to generate talk about language and text.

The pedagogy that evolves in this study for developing a metalanguage with students is very different from traditional genre pedagogy. Past studies emphasise how the teacher will build a metalanguage when deconstructing a model text at the beginning of the genre teaching and learning cycle (Dreyfus et al., 2016; Macnaught et al., 2013). During this process, the teacher will provide explicit examples that the students can then take into the joint and independent construction of text (Dreyfus et al., 2016; Macnaught et al., 2013). In this study, a teacher with little knowledge of genres and language began to build a metalanguage with students, not by undertaking the deconstruction of a model text, but by building into her teaching a moment when she focuses on language for discussing how language works in the disciplinary

context. The results here suggest that teachers, with little linguistic knowledge, may be best supported if there is a focus on the moments when classroom discussion of text and language can be generated within their learning sequences, rather than asking these teachers to engage in radical changes in practice that involve the deconstruction of model texts.

4.2 Comparing and contrasting texts to initiate and support classroom talk

The teachers were most successful in engaging students in reasoning about texts and language choices when they used the strategy of comparing and contrasting texts that may have been independently or jointly constructed. When Eliza invites the students to compare and contrast the jointly constructed definitions of transcription, she supports the students to reason about the concise and precise nature of scientific writing. No students select the particularly wordy definition of transcription and one student reasons that in this definition 'there is 'too much irrelevant information'. Eliza's invitation for the students to compare and contrast two definitions of translation also results in the students reasoning about the kind of information that is and is not included in the precise and concise definitions in science. The dialogue that takes place results in the students reasoning that a better definition will identify clearly and succinctly the key entities involved, will not include descriptive information about the entities and will indicate where a key activity is taking place. One student is then able to reason that one of the noun groups in the definition 'protein chain' could include more specific technicality and the classifier 'polypeptide' is suggested. The teaching strategy of inviting the students to contrast the two definitions results in the students reasoning about the nature of the definitions that are used in science to define complex activity sequences.

Parvati also engages the students in conversations about the nature of texts and language use through invitations to compare and contrast texts. As they are contrasting the beginnings of their visual representations for the activity sequence of transcription, two students reason about how these texts often begin with an overview of the cell, but then they need to focus in on the key entities within the cell and the nucleus to depict where the activities are taking place. The students reason that visual representations of activity sequences do need to provide detailed moments of activity, with key entities, the activity and the location of the activity depicted.

4.3 Practices for extending reasoning about text and language during classroom talk

The teachers use a number of specific practices to extend student reasoning within the classroom dialogue as they compare and contrast texts. One practice that the teachers use is to take up the idea of a student, elaborate on it and invite the student to extend their reasoning. For example, Eliza takes up the idea from one student that the second definition of translation contains the entity mRNA and she elaborates on this saying that the type of RNA is identified specifically. Eliza then invites the student

to consider other ways in which the two definitions are different from each other and the student extends their reasoning. Parvati also uses invitations for students to elaborate more on their reasoning. Her invitations often take the form of open questions, such as 'How? What are you trying to show me here?' or 'Why DNA?' Sometimes, she affirms a student's response before inviting the student to elaborate on their reasoning. For example, Parvati affirmed a student's use of a noun group to name a key entity by saying '[t]he nucleus good' and she then followed this up with a question inviting elaboration on their reasoning '[t]hat is why you are starting with the cell?' Another practice used by Parvati to support student reasoning during the comparison of texts is to focus in on specific parts of the texts. Throughout the dialogue, she supports students' reasoning by focusing in on specific elements that she wants them to compare and contrast. At one point Parvati also uses the practice of focusing on a part of the text and inviting a student to offer an alternative position to the one suggested by the teacher. Through this practice, the student reasons about which section of DNA will be transcribed and how he has depicted this in his visual representation.

4.4 Practices for creating opportunities for explicit language use in the disciplinary context during classroom talk

The practice of comparing and contrasting texts produces classroom dialogue in which students use appropriate technical language explicitly to present the key ideational meanings for the topic. As the students compare and contrast their texts, they use noun groups to identify specifically the key entities that are involved in the moments of activity (eg 'the cell', 'the nucleus', 'the specific gene'). One student uses the nominalisation 'expression' and forms the noun group 'gene expression' to identify a part of the activity sequence. Another student nominalises the process 'to attach' to name the activity of 'attachment' and then uses a qualifier 'of the polymerase' in the noun group to express the specific meaning that it is polymerase that is attaching during that part of the activity sequence. They then use the circumstantial phrase to be clear where the attachment is happening 'to the promoter' The same student uses a noun group to express how one entity in the activity sequence is composed of another: 'the gene of the DNA'. Throughout the dialogue generated when comparing and contrasting texts, the students use explicitly rich technical language to express key meanings about entities, processes and the places where the processes are happening.

At times, the teachers use specific practices that extend the explicit use of disciplinary language during text comparison and contrast. For example, as the students are reasoning about the differences between the two definitions of translation, Eliza uses the practices of taking up a student's response, affirming the response given and then recasting what the student has offered to use the more technical language of 'the cytoplasm'. The practices of affirmation and recasting used when comparing and contrasting texts in this study have also been documented as effective when

working with just one text (Gibbons, 2018). In Parvati's class, as the students are comparing and contrasting their two independently created texts, the teacher focuses a student's attention on part of their second text and invites a student to use a technical noun group to name a key entity they have drawn ('The nucleus'). In another example, Parvati focuses on another part of the visual representation in the process of being drawn and invites the student to talk about what they will do next. In their response, the student uses a complex noun group to name a key entity and to describe its composition: 'the gene of the DNA'. Rose's (2011, 2018a, b, 2023) studies of genre pedagogy also highlight the practice of focusing on part of a text to support dialogue about text. This study indicates that this practice is highly effective when teachers are asking students to compare and contrast texts as well.

4.5 Conclusion

Both teachers in this study took up the challenge of developing pedagogy for enhancing student engagement in purposeful classroom talk. Their practices successfully involve students in dialogue during which the students use explicitly language to express key meanings about activity sequences in senior high school biology. Both teachers also use successful strategies for supporting students to articulate their reasoning about texts and language. One teacher, Eliza, also provides opportunities for the students to engage in dialogue about a metalanguage. Using texts as prompts for student participation in dialogue, along with student opportunities to compare and contrast texts, are central to the evolving pedagogy. The texts that the students engage with are jointly or independently created, and these texts are then deconstructed during classroom talk. Both teachers move in flexible ways around the genre teaching and learning cycle as they focus on the generation of purposeful classroom talk. The evolving pedagogy also consists of specific practices that effectively engage the students in elaborated dialogue for reasoning about text and language including focusing on specific parts of texts, modelling part of a text, converting from technical to everyday language, converting nominalisations into the verb form, affirming students' responses, taking up the ideas of students, inviting further elaboration, recasting to more technical language and inviting an alternative perspective. Through the work of these two teachers, a complex pedagogy begins to emerge that effectively involves students in sophisticated reasoning about their text constructions and language use.

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REFERENCES

Anderson, T., & Shattuck, J. (2012). Design-based research: a decade of progress in education research? *Educational Researcher, 41*(1), 16-25. https://doi.org/10.3102/0013189X11428813

Barab, S., & Squire, B. (2004). Design-based research: putting a stake in the ground. *Journal of the Learning Sciences, 13*(1), 1-14. https://doi.org/10.1207/s15327809jls1301_1

Bourdieu, P., & Passeron, J-C. (1990). *Reproduction in education, society and culture*. SAGE.

Christie, F. (2013). Genres and genre theory: a response to Michael Rosen, *Changing English*, *20*(1), 11-22, https://doi.org/10.1080/1358684X.2012.757056

Christie, F. (2012). Language education throughout the school years: a functional perspective. Wiley-Blacwell.

Collins, A., Joseph, D., & Bielaczye, K. (2004). Design research: theoretical and methodological issues. *Journal of the Learning Sciences, 13*(1), 15-42. https://doi.org/10.1207/s15327809jls1301_2

Doran, Y.J., & J.R. Martin. (2021). "Field relations." In K. Maton, J.R. Martin, & Y.J. Doran (Eds.), *Teaching science: knowledge, language and pedagogy* (pp. 105-133). Routledge. https://doi.org/10.4324/9781351129282

Dreyfus, S.J., Humphrey, S., Mahbob, A., & Martin, J.R. (2016). *Genre pedagogy in higher education: the SLATE project*. Macmillan.

Edwards-Groves, C., & Davidson, C. (2017). *Becoming a meaning maker: talk and interaction in the dialogic classroom*. PETAA.

Fang, Z. (2005). Scientific literacy: a systemic functional linguistics perspective. *Science Education*, *89*, 335-347. https://doi.org/10.1002/sce.20050

Gebhard, M. (2019). *Teaching and researching ELLs' disciplinary literacies: systemic functional linguistics in action in the context of U.S. school reform*. Routledge.

Gibbons, P. (2018). Bridging discourses in the ESL classroom: students, teachers and researchers. Bloomsbury Academic. https://doi.org/10.5040/9781350063303

Gibbons, P. (2008). 'It was taught good and I learned a lot': intellectual practices and ESL learners in the middle years. *Australian Journal of Language and Literacy, 12*(2): 155–173. https://doi.org/10.1007/BF03651795

Gibbons, P. (2003). Mediating language learning: teacher interactions with ESL students in a content-based classroom. *TESOL Quarterly, 37*(2), 247–273. https://doi.org/10.2307/3588504

Gibbons, P. (1998). Classroom talk and the learning of new registers in a second language. *Language and Education, 12*(2), 99–118. https://doi.org/10.1080/09500789808666742

Halliday, M.A.K., & Matthiessen, C.M.I.M (2014). Halliday's introduction to functional grammar (4th ed). Routledge. https://doi.org/10.4324/9780203431269

Halliday, M.A.K. (1993a). Some grammatical problems in scientific English. In M.A.K.

Halliday & J.R. Martin (Eds.), *Writing science: literacy and discursive power* (pp.76-94). Farmer. https://doi.org/10.4324/9780203209936

Halliday, M.A.K. (1993b). On the language of physical science. In M.A.K. Halliday & J.R. Martin (Eds.), *Writing science: literacy and discursive power* (pp.59-75). Farmer. https://doi.org/10.4324/9780203209936

Hao, J. (2021). Building taxonomies. In K. Maton, J.R. Martin, & Y.J.Doran (Eds.), *Teaching science: knowledge, language and Pedagogy* (pp.134-161). Routledge. https://doi.org/10.4324/9781351129282

Hao, J. (2020). *Analysing scientific discourse from a systemic functional linguistic perspective: a framework for exploring knowledge building in biology*. Routledge.

Jones, P. & Chen, H. (2016). The role of dialogic pedagogy in teaching grammar. *Research Papers in Education, 31*(1), 45-69. https://doi.org/10.1080/02671522.2016.1106695

Kindenberg, B. (2021). Fixed and flexible, correct and wise: a case of genre-based content-area writing. Language *and Education, 64*, 1-12. https://doi.org/10.1016/j.linged.2021.100938

Kinnear, J., & Martin, M. (2016). *Nature of Biology 2*. (5th ed). Jacaranda.

Lo, Y. Y.& Jeong, H. (2018). Impact of genre-based pedagogy on students' academic literacy development in content and language integrated learning (CLIL). *Linguistics and Educatio*n, 47, 36–46. https://doi.org/10.1016/j.linged.2018.08.001

Lo, Y.Y., Lin, A.M.Y., & Cheung, T.C.L. (2018). Supporting English-as-a-foreign-language (EFL) learners' science and literacy development in CLIL: a genre-based approach. In K-S. Tang & K. Danielsson (Eds.), *Global developments in literacy research for science education* (pp. 75-95). Springer International. http://dx.doi.org/10.1007/978-3-319-69197-8_6

Macnaught, L., Maton, K., Martin, J.R., & Matruglio, E. (2013). Jointly constructing semantic waves: implications for teacher training. *Linguistics and Education, 24*, 50-63. https://doi.org/10.1016/j.linged.2012.11.008

Martin, J.R. (2017). Revisiting field: specialized knowledge in secondary school science and humanities discourse, *Onomazein, 51*, 111-139. http://dx.doi.org/10.7764/onomazein.ne2.05

Martin, J.R. (2013). Embedded literacy: knowledge as meaning. *Linguistics and Education, 24*(1), 23-37. https://doi.org/10.1016/j.linged.2012.11.006

Martin, J.R. (1993a). Life as a noun: arresting the universe in science and humanities. In M.A.K. Halliday & J.R. Martin (Eds.), *Writing science: literacy and discursive power* (pp.242-293). Falmer. https://doi.org/10.4324/9780203209936

Martin, J.R. (1993b). Literacy in science: learning to handle text as technology. In M.A.K. Halliday & J.R. Martin (Eds.), *Writing science: literacy and discursive power* (pp.184-222). Falmer. https://doi.org/10.4324/9780203209936

Martin, J.R. (1993c). Technicality and abstraction: language for the creation of specialized texts. In M.A.K. Halliday & J.R. Martin (Eds.), *Writing science: literacy and discursive power* (pp.223-241). Falmer. https://doi.org/10.4324/9780203209936

Martin, J.R., & Rose, D. (2008). *Genre relations: mapping culture.* Equinox.

Moje, E. B. (2015). Doing and teaching disciplinary literacy with adolescent learners: a social and cultural enterprise. *Harvard Educational Review, 85*(2), 254–278.

Myhill, D.A., Jones, S.M. & Wilson, A.C. (2016). Writing conversations: fostering metalinguistic discussion about writing. *Research Papers in Education*, *31*(1), 23-44. https://doi.org/10.1080/02671522.2016.1106694

Myhill, D.A., Newman, R. & Watson, A. (2020). Going meta: dialogic talk in the writing classroom. *Australian Journal of Language and Literacy*, *43*(1), 5-16. http://dx.doi.org/10.1007/BF03652040

Myhill, D. Newman, R. Watson, A and Jones, S. (2022) Writing dialogues: metalinguistic
talk about writing. In R. Solheim, H. Otnes, & M. Rijs-Johansen (Eds.), *Samtale, Samskrive, Samhandle* (pp.71-93). Universitetsforlaget.

Painter, C. (2005). *Learning through language in early childhood*. Bloomsbury.

Prain, V., & Tytler, R. (2013). Representing and learning in science. In R. Tytler, V. Prain, P. Hubber, and B. Waldrip (Eds.), *Constructing representations to learn in science* (pp.1–14). Sense Publishers. https://doi.org/10.1007/978-94-6209-203-7

Rose, D. (2023). Viewing to learn: intermodal pedagogy in science. *Linguistics and Human Sciences, 15*(3), 411-439.

Rose, D. (2021). Doing maths: (de)constructing procedures for maths processes. In K. Maton, J.R. Martin, & Y.J. Doran (Eds.), *Teaching science: knowledge, language and pedagogy*, (pp.257-286). Routledge. https://doi.org/10.4324/9781351129282

Rose, D. (2018a). Pedagogic register analysis: mapping choices in teaching and learning. *Functional Linguistics, 5*(1), 1–33. https://doi.org/10.1186/s40554-018-0053-01-33

Rose, D. (2018b). Languages of schooling: embedding literacy learning with genre-based pedagogy. *European Journal of Applied Linguistics, 6*(1), 59–89. https://doi.org/10.1515/eujal-2017-0008

Rose, D. (2011). Beyond literacy: building an integrated pedagogic genre. *Australian Journal of Language and Literacy,* 34(1), 81–97. http://dx.doi.org/10.1007/BF03651847

Rose, D. & Martin, J.R. (2012). *Learning to write, reading to learn: genre, knowledge and pedagogy in the Sydney School*. Equinox.

Rosen, M. (2013). How genre theory saved the world. *Changing English*, *20*(1), 3–10. https://doi.org/10.1080/1358684X.2012.757055

Rothery, J. (1996). Making changes: Developing an educational linguistics. In R. Hasan & G. Williams (Eds.), *Literacy in Society* (pp.86-123). Longman.

Schleppegrell, M.J. (2024). Value your students' bilingualism? Nurture them through development of school-based registers! *Language Teaching*, (02), 1-12. https://doi.org/10.1017/S0261444823000459

Schleppegrell, M.J. (2004). *The language of schooling: a functional linguistics perspective*. Lawrence Erlbaum.

Vygotsky, L. S. (1962). *Thought and language*. MIT Press.

Weekes, T. (2022). Review of literature around literacy transition. In P.T. Jones, E.

Matruglio & C. Edwards-Groves (Eds.), *Transition and continuity in School Literacy Development* (15-28). Bloomsbury Academic. https://doi.org/10.1080/00131911.2022.2109329

Williams, G. & Hasan, R. (1996). Introduction. In R. Hasan & G. Williams (Eds.), *Literacy in Society* (pp.xi-xxi). Longman.