Grammar for Science: Pairing Form and Function for Technicality, Precision, and Persuasion

Jodie L. Martin

This article describes how a class dedicated to supporting language needs in concurrent science courses developed complex grammatical literacy with an emphasis on a functional understanding of language for technicality, precision, and persuasion. The success of the curriculum was predicated on three factors: the grammatical content selection and sequencing, activity design, and assessment design, all motivated by the needs of the students in their concurrent courses. Specific content was chosen, including transitivity and clause forms, the systemic functional grammatical concepts of logic, circumstances, and grammatical metaphor, and the Appraisal notion of engagement. By moving from forms of language to functions and meanings, students built the skills to negotiate complex grammatical structures in textbooks and word problems and therefore access the scientific knowledge. Regular group work and discussion focused on texts that students brought from their science classes, allowing students to slowly build familiarity with concepts in a way that emphasizes scientific understanding over grammatical perfection. The assignments included group analyses, a short conversation with the instructor on an individual analysis, and both individual and pair written assignments where sources were rewritten with strategic language use to paraphrase and position sources, claims, and information. While achievement levels varied, students anecdotally reported being able to read more quickly, identify key information under exam conditions, and apply the knowledge learned in new courses and assignments.

Cet article décrit comment un cours dédié au soutien des besoins linguistiques dans des cours de sciences concomitants a développé une littératie grammaticale complexe qui met l'accent sur une compréhension fonctionnelle de la langue pour la technicité, la précision et la persuasion. Le succès du programme d'études repose sur trois facteurs : la sélection et l'enchaînement du contenu grammatical, la conception des activités et la conception de l'évaluation, tous motivés par les besoins des apprenants dans le cadre de leurs cours concomitants. Un contenu spécifique a été choisi, notamment la transitivité et les types de propositions, les concepts de la grammaire systémique fonctionnelle, comme la logique, les circonstances et la métaphore grammaticale, ainsi que le concept de l'évaluation de l'engagement. En passant des formes linguistiques aux fonctions et aux sens, les étudiants ont acquis les compétences nécessaires pour négocier les structures grammaticales complexes des manuels et les défis lexicaux complexes et ainsi accéder aux connaissances scientifiques. Les travaux de groupe et les discussions régulières ont porté sur des textes que les étudiants avaient apportés de leurs cours de sciences, ce qui leur a permis de se

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familiariser progressivement avec les concepts d'une manière qui met l'accent sur la compréhension scientifique plutôt que sur la perfection grammaticale. Les devoirs comprenaient des analyses de groupe, une courte conversation avec l'enseignant basée sur une analyse individuelle, et des devoirs écrits individuellement et en binôme où des sources étaient réécrites avec une utilisation stratégique de la langue pour paraphraser et positionner les sources, les affirmations et les informations. Bien que les niveaux de réussite aient varié, les étudiants ont déclaré être capables de lire plus rapidement, d'identifier les informations clés en contexte d'examen et d'appliquer les connaissances acquises dans de nouveaux cours et de nouveaux devoirs.

Keywords: curriculum design, English for Academic Purposes, grammar-based instruction, science education, systemic functional linguistics

Grammar and science face a similar challenge: both linguistics and the various disciplines of science conceptualize artefacts and interactions of immense complexity. Both fields, therefore, have developed concepts and patterns of writing to convey knowledge to other experts and to novice or general audiences. Any teacher, instructor, lecturer, or professor must therefore strategically select and sequence core concepts for students, and in some way present the language of the field. Rose and J. R. Martin (2012) explain, "Teaching language explicitly means bringing unconscious knowledge about language to consciousness. To do this, teachers and students need to be able to name what they are talking about, and this involves a systematic understanding of how language works" (p. 236). Unpacking the language of any disciplinary text requires an understanding of specialist vocabulary or meanings and communicative purpose (Bruce, 2011). This article describes an academic English course within a first-year science program for international, multilingual students, where grammatically explicit instruction provided this understanding. This course design incorporated concepts from systemic functional grammar (Halliday & Matthiessen, 2014; Rose & J. R. Martin, 2012) to help these students to read, write, and present in concurrent science courses.

Systemic functional linguistics (SFL), in its conception, was inspired by the experience of teaching language and developing explanations to support students (Halliday & Hasan, 2006). While its extensive framework and specific metalanguage may be daunting to prospective teachers, its attention to form within meaning and its descriptive rather than prescriptive focus on meaning potential make it well suited as a pedagogical grammar (McCabe, 2017). Indeed,

> SFL theory does not shy away from the complexity of language, which may make it difficult for teachers and learners who want simplification, especially in the early stages of learning. At the same time, its complexity of description is designed to capture the complexities of language in use, which suggests greater adequacy of description for pedagogic purposes when learners need guidance in lining up the meaning potential of the system with actual instances of language as instantiated in text. (McCabe, 2017, p. 597)

Rather than theoretical fidelity and grammatical perfection, the classroom requires a pragmatic and practical approach (Macken-Horarik et al., 2011), and SFL has informed teaching in primary, secondary, and tertiary education, especially in Australia. In Canada, however, it does not appear to have reached as

far (see Duff et al., 2015; Priven et al., 2024, for applications in two Canadian EAP programs), so this article aims to demonstrate its usefulness for interested teachers and curriculum writers, in both academic English and scientific writing programs. A select number of recommended resources on SFL for teachers are provided in the Appendix.

SFL is a powerful toolkit for examining disciplinary academic English (Monbec, 2020), with its long attention to both the "science of language" (Halliday & Hasan, 2006) and the "language of science" (Halliday, 2004; Halliday & J. R. Martin, 1993). There are now SFL descriptions of scientific fields such as biology (Hao, 2020) and physics (Doran, 2017), which can be used by an instructor to inform lesson design. SFL has been demonstrated to support science at multiple levels of education, from elementary (Accurso et al., 2016) to middle school (Fang & Wei, 2010) to high school (Maxwell-Reid & Kartika-Ningsih, 2020). In the context described in this article, SFL was both an institutionally supported approach for the academic English program and the educational background of the author and lecturer.

This article provides an extended description of an academic English course that centred on select grammatical concepts for the explicit purpose of supporting English language learners in their concurrent science studies. I will first describe the learners and context, with particular focus on the factors that enabled this curriculum to work. After a brief overview of the curriculum as a whole, I explain how two design concepts shaped the curriculum and then present the activities and assessments that followed these concepts. Finally, I describe in detail the grammatical content of this course, with examples taken from my class slides and activities, along with the rationale for selecting this content. While the context described may be somewhat unique, it is hoped that the details of the curriculum design process, the particulars of activities and assessments, and the demonstration of selected grammatical features with examples of classroom materials will provide an illustration and example for any reader interested in including grammatical content in their classes, whether they are focused on EAP, science, or otherwise.

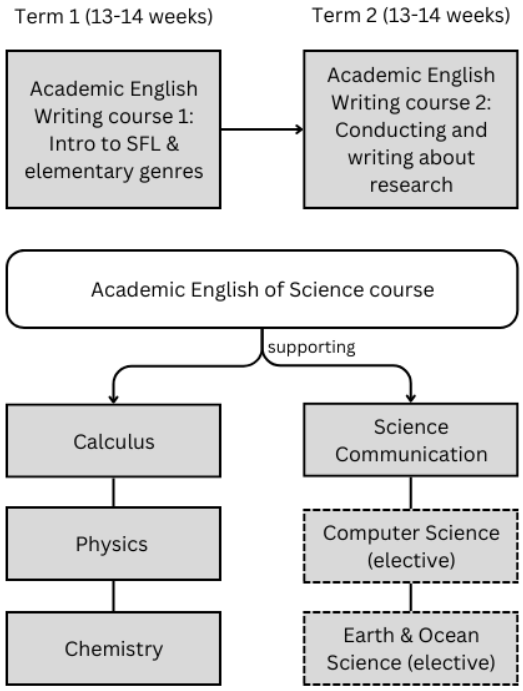
Learners and Context

The curriculum was designed within a program that officially adopted explicit grammatical instruction using systemic functional grammar (Halliday & Matthiessen, 2014) and genre-based teaching (Rose & J. R. Martin, 2012) in order to support international first-year science students to meet language standards alongside their science courses (Duff et al., 2015; Ferreira & Zappa-Hollman, 2019; Zappa-Hollman & Fox, 2021). The Vantage College Science One program at the University of British Columbia takes students whose language test scores are slightly below the university entry requirements and provides two academic English courses alongside the first-year science courses, as shown in Figure 1, with students who successfully pass the academic English courses (as well as the science courses) continuing to second-year mainstream classes. Importantly, the program also includes small class sizes (15 in the writing course, 25 in the science language course). These small class sizes and complementary courses created a supportive environment to go in depth with contextualized grammatical instruction. That is, as a writing-focused academic English course taught an introduction to systemic functional grammar and its application in writing in certain elementary genres, the science language course could selectively incorporate grammar that was of use for the specific needs of the science courses and apply, expand, or elaborate on grammar from the writing-focused course.

The curriculum was originally developed for the 2020–21 academic year when travel restrictions and emergency remote instruction during the COVID-19 pandemic meant the majority of students in the program were out of the country, in a variety of time zones that made synchronous instruction challenging. These circumstances provided a catalyst for an overhaul of the curriculum, involving consultation with the science lecturers who taught concurrent courses, close reading of the textbooks, and a review of

Figure 1

Course Context



assessments. Having also taught the writing-focused courses, I was able to explore ways to complement the core content of those courses by applying concepts directly to science materials, extending their instruction, or adding concepts that were not included. Consequently, this curriculum is designed to suit this particular context, as all good curricula are; while it may not be directly transferrable to other contexts, the principles of its design, delivery, and practice provide proof of concept for how students can be supported to develop a productive knowledge of grammar relevant to their learning context and content.

Curriculum Overview

From the initial consultation with science instructors and review of their materials and assignments, as well as with ongoing review while observing students' experiences, the curriculum was designed to focus on certain grammatical features that could support students' language needs. As shown in Figure 1, the language course ran over two semesters (each 13–14 weeks) and simultaneously supported six semester-long courses, three per semester. The first semester's focus was on the core science disciplines of physics, chemistry, and calculus: these courses involve a lot of reading, whether through hard-copy textbooks or textbooks delivered online through a learning management system. As these textbooks often include both technical and precise grammar (e.g., extended noun groups with technical terminology), and complex speech-like grammar (e.g., embedded clauses, interrupting clause complexes, minor clauses), students immediately need support in deconstructing the complexity in order to access the specific scientific knowledge. Further, they benefit from deeper attention to grammatical concepts not covered in depth in

the writing course, concepts that often provide key meanings to understand the content or solve the problems. In the second semester, students take a separate science communication course designed and delivered by science instructors without writing or language expertise, focused on the nature of knowledge in science, with assessments in the form of argumentative essays with claims, reasons, and evidence. As such, the interpersonal aspects of persuasive writing need to come to the fore; in addition, as students grapple with using sources, issues around inadequate paraphrasing and citing start to emerge more frequently. Therefore, the concepts that help students position and frame claims somewhat objectively are introduced in the first half of the semester. The course also repurposed concepts from the first semester for writing instead of reading. At the same time, an effort was made to build on and extend the grammatical concepts covered in the concurrent academic English writing course, rather than duplicating instruction, although some overlap was necessary to accommodate variation between instructors. Finally, an extended focus on presentations prepared students for their concurrent courses' assessments, as well as for the end of program conference presentations they give a few months later. While the shift in modalities was productive at a busy time of the term, it in fact provided the opportunity to operationalize language understandings multimodally, through images, slide text, and spoken language. Focusing these presentations on their science topics also further developed their audience awareness for language use and shifts between writing and speaking academically when discussing technical topics.

Given the identified language needs of the students—namely, deconstructing technical language and complex grammar to access scientific meanings and details in the first semester, and paraphrasing and positioning claims and sources in the second semester—a very specific set of grammatical concepts were selected and organized according to the design principles discussed in the next section. The units of instruction with their associated grammatical concepts are summarized in Table 1, along with the core purposes, and the activities and assessments, described further in the following sections.

Creating Space to Learn

Within English for Academic Purposes classes, the needs analyses of the students must be fundamentally related to theories both of language and of teaching and learning (Bruce, 2011). While SFL provided the language theory, two key curricular design concepts were important both to sequencing the content and to planning the activities and assessments to support the learning of grammar: the Teaching and Learning Cycle (TLC) (Rothery, 1994) and cumulative knowledge-building (Maton, 2014).

The Teaching and Learning Cycle is a curriculum model that focuses on language instruction with high expectations met through the intentional establishment and gradual release of scaffolding aiming toward control of critical orientation to skills, knowledge, and language (Dreyfus et al., 2016; Rose & J. R. Martin, 2012). The course curriculum was therefore designed, as depicted in Figure 2, with repeated iterations of building the field (establishing key terms and relevant knowledge), modelling and deconstruction (showing different texts and examples from textbooks, and breaking them down to reveal grammatical features) before joint construction (through teacher-scaffolded individual activities like quizzes, or group or pair work supported by instructor and teaching assistant). Finally, the summative assessment required independent construction by the student, who had a greater chance of success given these preparatory activities and supports. By repeating these cycles with similar but different content, and similar but extended assessments, students also had the opportunity to receive feedback and improve on performance. The cycles of activities and assessments and the purposeful connections between assessments are depicted in Figure 3, with further details of the assessments provided in a later section.

Table 1

Course Content Selection and Sequencing

Unit	# of weeks[a]	Grammatical concepts	Core purpose	Activities and assessment
First term				
0 Introduction	1–2	Register, transitivity	Intro and basic concepts	Group work, no assessment
1 Clauses and logic	4	Clause forms (finiteness, (in)dependence) Clause position (ranking/embedded) Interrupting clauses Logic types (projection/elaboration)	Reading and understanding textbooks and word problems in science	Group work activities Group work assessment: grammatical analysis of text with summary of analysis
2 Circumstances and precision	4	Circumstance forms (adverb/prepositional phrase/nouns) Circumstance position (ranking, embedded, fronted) Circumstance types (21 types)	Reading and understanding textbooks and word problems in science	Group work activities Group work assessment: grammatical analysis of text with summary of analysis
3 Grammar for Science	3	Logical grammatical metaphor	Reading and understanding textbooks and word problems in preparation for final exams	Individual analysis with one-on-one discussion with instructor
Second term				
4 Repositioning in writing	6–7	Using clauses, logic, and circumstances strategically in writing and paraphrasing Interpersonal grammatical metaphor Engagement and attitude Subjectivity/objectivity	Paraphrasing and using sources in writing science arguments	Individual repositioning assignment Paired repositioning assignment
5 Presentations	6–7	Intermodal logical relations between images and speech Grammar of bullet point form on slides Semiotics of slide design Grammar for accessible technical topics	Preparing students to present in courses and conferences	Individual PechaKucha presentations Paired academic slide show presentations

[a] Each week equates to 160 minutes of class time.

Figure 2

Application of the Teaching Learning Cycle to this Course

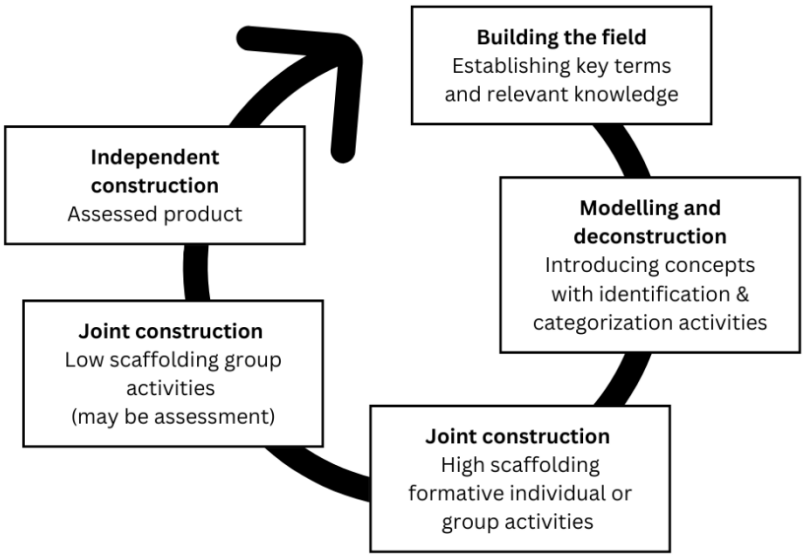
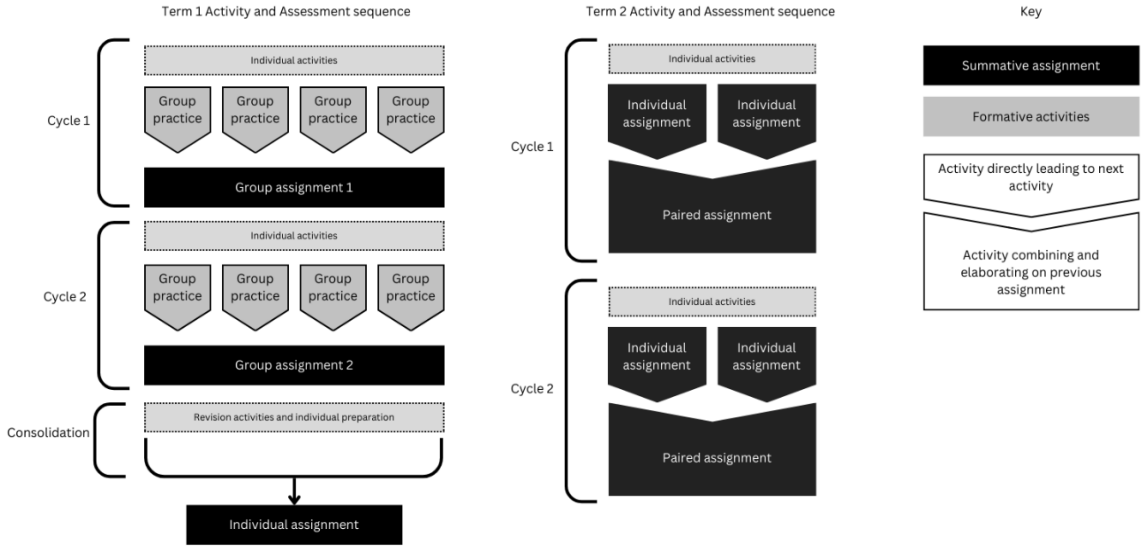


Figure 3

Activity and Assessment Cycles



The concept of cumulative knowledge-building is differentiated from segmented knowledge-building (Maton, 2014; Maton et al., 2016); that is, instead of concepts being taught in distinct and separate phases, they cumulatively build on each other over the period of the course. This is particularly useful when considering a grammar-forward approach to teaching, as grammatical features are often interconnected and mutually dependent. Segmented knowledge-building is similar to what Bruce (2011) describes as synthetic syllabi—where learners learn one concept at a time. While the curriculum does broadly differentiate units 1 and 2 with grammatical concepts, units 3–5 centre purposes of language use, with the first units providing a grounding that is structural, functional, contextual, and overlapping. Aspiring to a cumulative knowledge-building model means that grammatical knowledge taught in week 1 continues to be relevant in subsequent weeks, as illustrated in Table 2, where selected grammatical features are taught primarily in the units indicated by the grey highlighted boxes but are incorporated in other units with shifting focus on identification and application for different purposes. Each term also ends with a unit reviewing and elaborating on previous material. Each topic builds on the previous one, and each assignment integrates aspects of preceding assignments, as depicted in Figure 3. This is distinct from segmental learning models of language learning, where each unit of study is self-contained and self-assessed. The risk of a cumulative model is that students who miss key content early on may fall behind; the reality is that the continual relevance of the content is more likely to keep it active in their understanding and enables students to build a more complex knowledge system. It also facilitates the transfer of knowledge: each grammatical structure is not confined to the topic that happened to be the example of that unit. Rather, the knowledge is repeatedly reactivated in new contexts with new content.

Overall, the pedagogical space for students to build practical grammatical knowledge is created by choosing immediately relevant content to help with technicality, precision, and persuasion, and introducing it through cycles of teaching and learning within a cumulative trajectory for the whole semester.

Activities and Assessments

A key to developing grammatical awareness in science students is the design and sequencing of activities and assessments that build capacity or are authentic to students' concurrent or near future needs. Following the principles of the TLC (Rothery, 1994), formative activities were incorporated prior to summative assessments, and pairs of similar assessments with increasing complexity helped to build capacity, as depicted in Figure 3.

The first step in formative activities for building grammatical awareness is typically identification-style tasks through analysis of selected sentences or passages from their textbooks, or quizzes. These may be completed independently or collaboratively. This gives students some initial exposure to the concepts with clear examples, sometimes taken from textbooks with lower-level tasks (Humphrey et al., 2012; J. R. Martin et al., 2010). Importantly, the next step is to apply the concepts to the textbooks that the students are reading. Once a week in first semester, students work in small groups to analyze excerpts they have selected from their textbook readings. These readings are unavoidably complicated; real language often is. The goal of the formative activity, therefore, is for students to reach a functional understanding—both in the sense of functional grammar and with respect to having one that works for their personal understanding of scientific English. Often through negotiation with others, students come to a clearer understanding of the text, or clarify some mistakes, and it does not matter whether the grammatical category is perfect. Nevertheless, this immediate but low-stakes application facilitates the transfer of the concepts and a practical grasp of them. As these tasks are formative and ungraded, they enable greater scaffolding to guide students to the answers and to model more examples as they develop their awareness.

Table 2

The Use of Selected Grammatical Items throughout the Course

Unit	Conjunctions	Circumstances	Modality
0 Introduction	Part of the clause (transitivity) Help identify beginning of clause	Part of the clause (transitivity) Answer the questions where/when	Part of verbal group (process)
Pedagogical foci:	IDENTIFY	IDENTIFY	IDENTIFY
1 Clauses and logic	Help typologize clauses (in/dependent) Indicate type of Logic	Differentiate from connectors Not clauses in themselves	Give clause "finite" status
Pedagogical foci:	FORM IN CONTEXT FUNCTION	IDENTIFY	IDENTIFY
2 Circumstances and precision	Similar but different to circumstances	Forms of adverbial groups Types of circumstances Patterns of meanings	(Modal adverbs may be covered in context)
Pedagogical foci:	FUNCTION IN COMPARISON	FORM & FUNCTION PATTERNS OF MEANINGS	FUNCTIONS IN CONTEXT
3 Grammar for science	Patterns show key logical meanings in science Logical grammatical metaphor: logic can be expressed by connectors	Patterns show key circumstantial meanings in science Logical grammatical metaphor: logic can be expressed in circumstances	May be used in textbook excerpts
Pedagogical foci:	MEANING PATTERNS IN READING	MEANING PATTERNS IN READING	
4 Repositioning in writing	Grammatical metaphor: can move logic from conjunction to adverbial group, verb or noun Projection can position statements	Grammatical metaphor: can turn clauses into circumstances for paraphrasing Modal adverbs provide expansive meanings Circumstances of angle indicate sources and engagement	Modal finites: key resource for expanding meanings (engagement) Interpersonal grammatical metaphor: expressing modality with different grammatical resources or phrases
Pedagogical foci:	STRATEGIC USE IN WRITING	STRATEGIC USE IN WRITING	STRATEGIC USE IN WRITING
5 Presentations	Like connectors connect ideas, similar logic can connect images and language Projection to direct audience's attention to slides (The graph shows THAT…)	Circumstantial detail provided by images Few circumstances used in point form Circumstances of angle to indicate sources Circumstances of location to direct audience's attention to slide	May be used less in academic speech than writing
Pedagogical foci:	INTERSEMIOTIC MEANINGS	INTERSEMIOTIC USES	

Summative assessments ask students to demonstrate grammatical awareness developed in these formative activities on new texts. The first two assignments are grammatical analyses with short summaries of findings completed as group tasks on new, student-selected textbook excerpts. The grammar discussion provided an individual check-in through a conversation about an analysis each student had prepared earlier on the use of logic and circumstances in texts that their science instructors had identified as worthy for review before their final exams. The discussion format enabled the students to demonstrate their grammatical knowledge and connect it practically to their scientific knowledge (Walton & J. L. Martin, 2025). In the second term, the repositioning unit incorporates two assignments, the first one completed individually in order to consolidate individual skills and the second in pairs. In both assignments, students reposition excerpts of text through paraphrasing and referencing and explain the grammatical choices made in the writing. In terms of grammatical content, the first draws on grammatical features covered in the first term—clauses, logic, and circumstances, and register features—and adds referencing conventions, while the second incorporates interpersonal strategies of engagement. This activity effectively scaffolds and assesses a range of performance: weaknesses can be clearly identified when students explain what they intended to write, or fail to explain it clearly, while providing an opportunity to demonstrate sophisticated and strategic grammatical awareness.

The assignments in this curriculum are customized to build specific grammatical skills that are simultaneously or subsequently applied in students' concurrent science courses. It is worth exploring why these assessments are authentic to student needs. The grammatical analyses build students' capacity to deconstruct complex passages and identify key meanings in the English expression. This helps them to read textbooks as well as word problems in homework, assignments, and exams and also elucidates nuances of English language structures in a way that translation may not. For example, students need to interpret embedded post-modifying clauses as providing information about a particular noun, not the whole clause; similarly, if they interpret "as" to mean "because" instead of "at the same time," the scientific meanings could be misunderstood. The grammatical discussion is an effective way to encourage students to review both science and language materials for their final exams and demonstrate knowledge transfer by explaining why, for example, physics uses a lot of circumstances of location: place[1] (to identify locations of objects and forces). The repositioning assignments have students provide their original texts, their paraphrased versions, and their explanations; this prepared them for incorporating sources in their argumentative assignments in science communication. In order to assess students' understanding of authentic complexity, a controlled task scaffolded grammatical knowledge in an assessable format. Ultimately, success comes not in the academic English course but in the concurrent science courses, and in the following years of their studies, when they continue to use academic English successfully.

The evaluation of grammatical knowledge can be daunting to instructors who are not confident of their own grammatical knowledge; furthermore, authentic texts often provide grammatical conundrums. There are three principles to follow in an attempt to be fair in assessment: (1) the difficulty of the text is taken into consideration for the grading; (2) the analysis is faithful to the way concepts were taught in class; and (3) the analysis is plausible according to the students' understanding of the scientific meanings. In this way, students who had fewer errors on a simple text did not necessarily get a higher grade than students who had more errors on a complex text. Similarly, mistakes that directly contradicted a point taught in class were marked more harshly than mistakes that grappled with an unusual grammatical form that had not been covered in class. Finally, students could double-code and justify choices, particularly where the

[1] For grammatical types with two levels, SFL often uses a colon to label both main and subcategory, such as location: place as compared to location: time. For more examples see Unit 2: Circumstances for Precision, below.

scientific meanings were somewhat ambiguous. For example, students explained to me that a prepositional phrase referring to the movement of an electron (to a higher energy level) could be interpreted as referring to a location in an accompanying graph, or to a state of being, thus a circumstance of location: place or of manner: means.

The activities and assessments together are key to realizing both TLCs and cumulative knowledge-building and fundamentally teaching grammar in a way that is practical and transferable. In the end, I did not expect my students to be able to perfectly identify a post-modifying embedded non-finite clause, or a circumstance of role: product for the rest of their degrees. I do believe however that drawing their attention to these features that are both structural and semantic for an extended period of time builds a fluency and familiarity with academic English that would have taken longer to develop through exposure and immersion.

Grammatical Content and Sequencing

This section describes specific details of the grammatical content selected for instruction and provides theoretical and practical definitions, rationale, and examples as space permits. It should be noted that some compromises were made in terms of theoretical fidelity in favour of classroom pragmatism: this course did not give a full and thorough accounting of systemic functional grammar but rather selected key concepts that could be connected and fundamentally help students grasp and master the language of science and of university. The following sections are organized according to the units, though of course there was overlap and cumulative reiterations as detailed above.

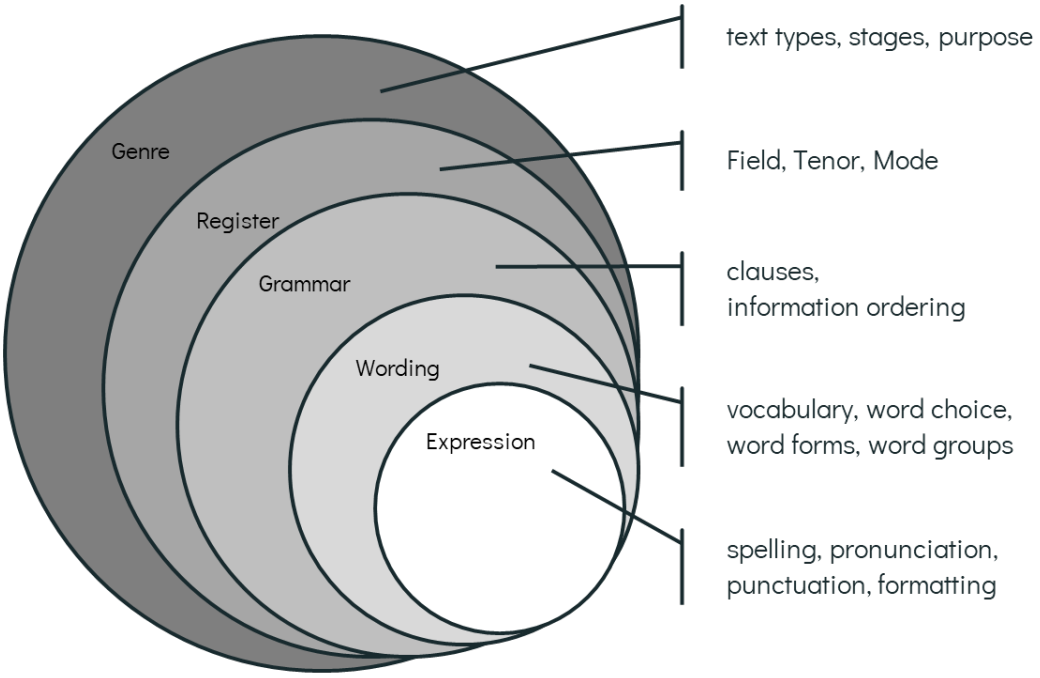
Unit 0: Introduction

Within SFL, *register* is one of the main concepts used to connect language to context (J. R. Martin & Rose, 2007), and it is organized metafunctionally into *field* (which deals with the substantive topic of the text), *tenor* (which deals with the complexity of the relationships between interactants, such as the writer and reader), and *mode* (which covers the role of language and the organization of language into recognizable texts). The course began with an overview of register (see Figure 4) to enable language features to be mapped to context by identifying continua such as everyday-technical (field), equal-unequal power (tenor), and interactive-non-interactive (mode). Throughout the first semester, the specific language choices of textbook authors were connected to their technical scientific content, their pedagogical purpose, their novice audience, and the written format. To start, we explored the differences between emailing an instructor for the first time and messaging a friend, or between talking about science to a child, a friend, or an expert.

In order to prepare for the subsequent foci of clauses, logic, and circumstances, it is necessary to begin with a practical introduction to the components of the clause, so the first grammatical details are introduced early with a lesson on transitivity. Rather than grammatically precise definitions, this lesson aims to access intuitive notions of language (what is going on, who is involved, where, and when) as well as integrate and build on metalanguage that students may have from prior studies (such as verb and noun) (Rose & J. R. Martin, 2012). Instead of looking at words, attention is shifted to groups of words in order to "chunk" the language differently; the identification of verbal groups, noun groups, adverbial groups, and conjunctive groups are then connected to their functional labels from systemic functional grammar with

Figure 4

The Language Planes



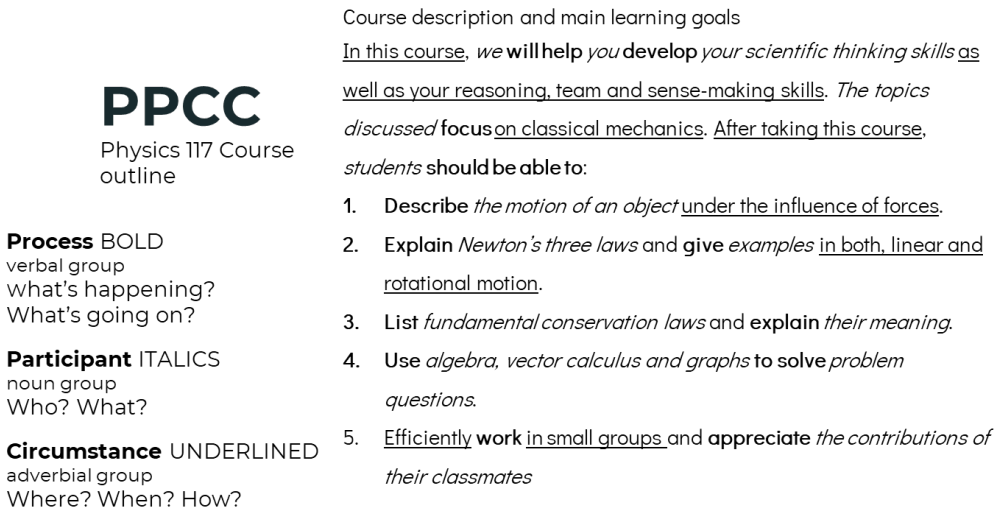
Note. Adapted from Rose & Martin (2012)

the acronym PPCC[2]—Process, Participant, Circumstance, Connector. Figure 5 shows a slide from one of the first classes demonstrating basic transitivity analysis with grammatical form and question prompts. It is worth noting that this example includes a non-finite clause, "After taking this course," as a circumstance (adverbial group), since at this early point it is easier to address it as the answer to the probe question "where?," even though later it will be more accurately coded. This initial introduction to metalanguage and practice examining clauses also aims to support students breaking down complex sentences they encounter in their science readings into their constituent parts to decode, rather than use automatic translators. One useful piece of software for support in recent years has been the Immersive Reader embedded in Microsoft Word programs, which automatically, but imprecisely, identifies parts of speech. This helped to begin to discuss the differences between a verb used as part of the verbal group (process) and a verb used to classify a noun in a noun group (participant).

[2] I am indebted to Dr. AJ Jackson for this pedagogical adaptation, which he uses productively in middle-school English literature classes in the United States.

Figure 5

Slide Example of Basic PPCC Analysis of the Outline of the Physics Course



Unit 1: Clauses and Logic

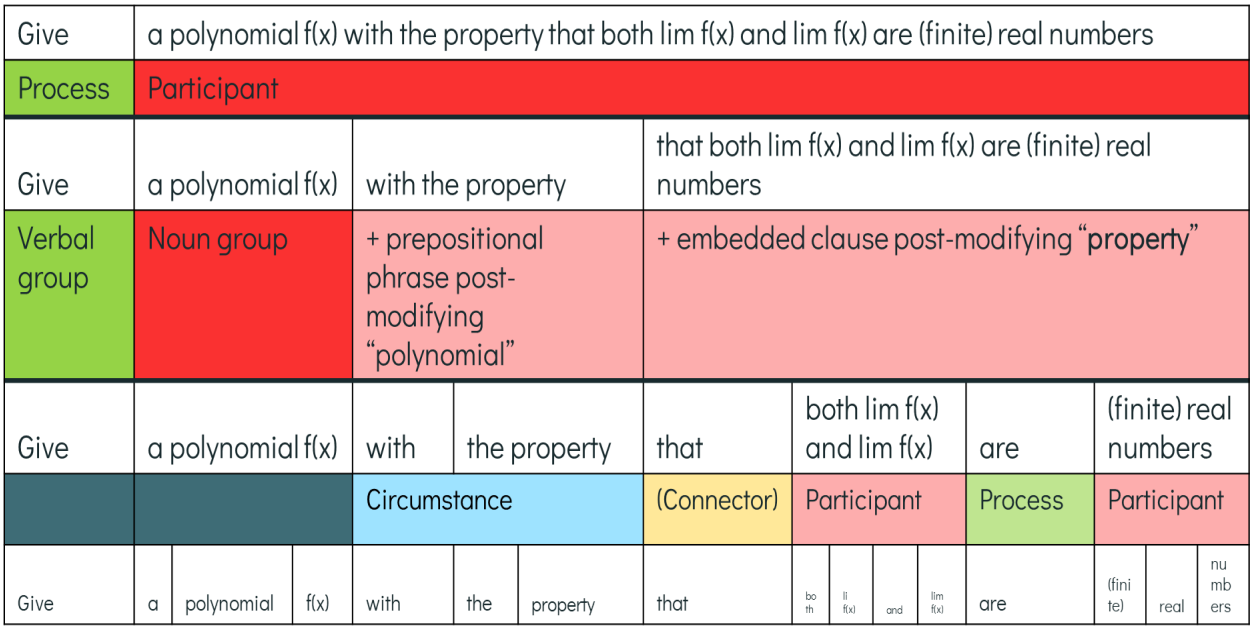
The first substantive unit focused on clauses and the systemic functional concept of logic. By introducing complex structural elements early on, students were given as much time as possible to develop analytical awareness and were immediately given strategies for breaking down complex language they would encounter in their studies without relying so much on translation. The concepts I have found both helpful and necessary include in/dependence, finiteness, imperatives,[3] embedded clauses, and whether clauses are interrupting (ranking clauses in the middle of another clause without embedding) or not. These immediately build on transitivity and PPCC as an analytical strategy as students continue to identify verbal groups to find the clauses and identify clausal characteristics. They also help students understand the complexity of nominal expansion through embedding (Maxwell-Reid & Kartika-Ningsih, 2020). For example, Figure 6 displays an instruction sentence from the math textbook, which features embedded prepositional phrases and clauses, and shows how it can be analyzed at different ranks more productively than word by word.

While clause forms help reveal the structure of language and are particularly useful for both technical and speech-like textbook writing, the logic concept highlights the meaningful links between (and within) the clauses. Logic includes the distinction between projection (of speech or thought) and expansion of clauses and, within the latter, the enhancing (through contextualizing), extending (through adding), and elaborating (through exemplifying) of clauses (Halliday & Matthiessen, 2014). The connectors identified by

[3] I have not found it necessary to cover interrogative forms, despite their frequency in word problems.

Figure 6

Slide Demonstrating Function and Form through Colour Coding, and Embedded and Grouped Constituents



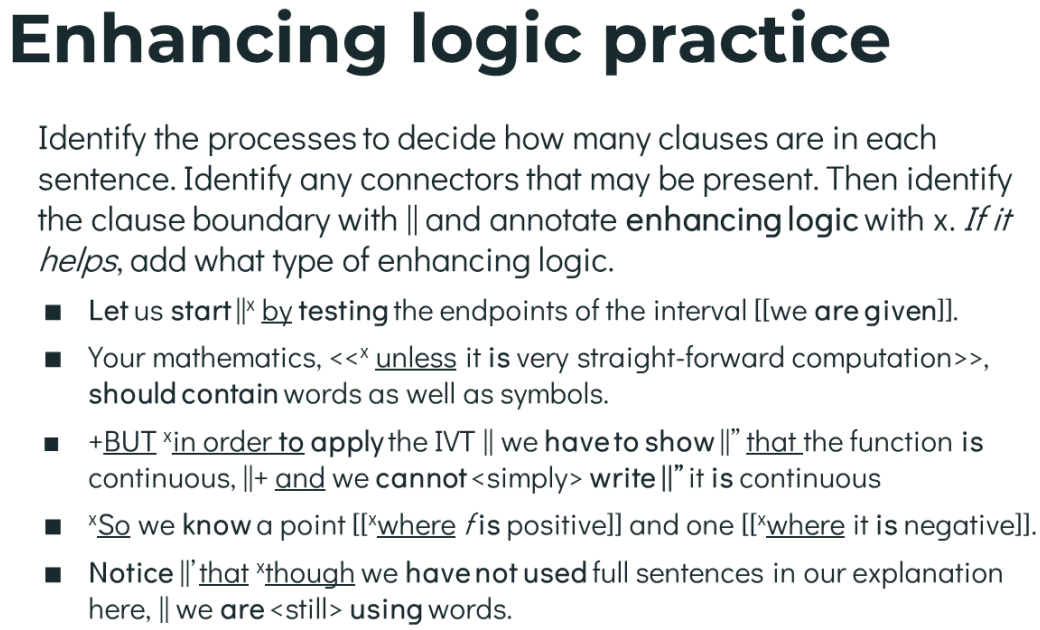
PPCC are therefore matched to the functional logical labels, with emphasis given to how the same connector can express different types of logic; for example, "as" can make a causal connection or a temporal connection. I initially used simplified pedagogical lists of logic types aimed at K–12 education but then shifted to the full logic tables from Halliday and Matthiessen (2014) to detail the logical relations rather than trying to categorize all the conjunctions for the students. Students could thus consider what logic is being used by both connectors and sometimes punctuation in context. The example in Figure 7 demonstrates the use of embedded clauses (indicated by square brackets) and even interrupting clauses (indicated by chevron brackets), while the notation shows a wide range of logic including projection (‘ “), enhancing (^{x}), and extending (+).

Unit 2: Circumstances for Precision

The second unit zooms in on one category of PPCC: circumstances. Circumstances take the form of adverbial groups, represented by adverbs, prepositional phrases, and a few nouns, and are often underrepresented, undertaught in classes, and, overall, underestimated (Walsh Marr & J. L. Martin, 2021). They have been included partly because the writing-focused course does not spend much time on them; however, Example 1 shows a mathematics word problem where, if the underlined circumstances were left out, all the key details of the problem would be lost.

Figure 7

Analysis Activity Slide Identifying Clause Boundaries and Types of Logic



Example 1: Mathematics Word Problem Analyzed for Processes and Circumstances

A wealthy man **was found** murdered in his home at 10pm at night. The temperature of his body **was** 33◦C, and of the room 21◦C. An hour later the temperature of the body **was** 31◦C. **Assume** the body **cools** after death according to Newton's Law of Cooling.

Key:
Processes
Circumstances

Circumstances work particularly well after logic, as some of the meanings overlap; this provides an opportunity to clarify and distinguish dependent clauses from circumstances, and embedded clauses and embedded circumstances (Dreyfus & Bennett, 2017). The chemistry example in Figure 8 demonstrates the importance of paying attention to embedded prepositional phrases and understanding whether they are, for example, giving the location of a previous noun (number of apples, ring) or the location of the verb (summing).

In contrast to the first unit, the bulk of instruction focuses on the 21 types of circumstances (Halliday & Matthiessen, 2014), an attention justified by the fact that almost all types manifested in a single week's readings across the three science courses, as exemplified in Figure 9. The extensiveness of the types is one reason they are rarely included both in writing courses or even substantially in textbooks (Walsh Marr & J. L. Martin, 2021); however, that complexity provided the stimulus for students to debate specific meanings and enhance their understanding of the scientific language and knowledge. This focus on circumstances highlights key circumstantial details involved in science and often given in science problems: the location of the projectile, the degree of the angle, the method of the experiment, the cause of the reaction, and the conditions of the experiment.

Figure 8

Slide Analyzing Embedded Circumstances in a Chemistry Example

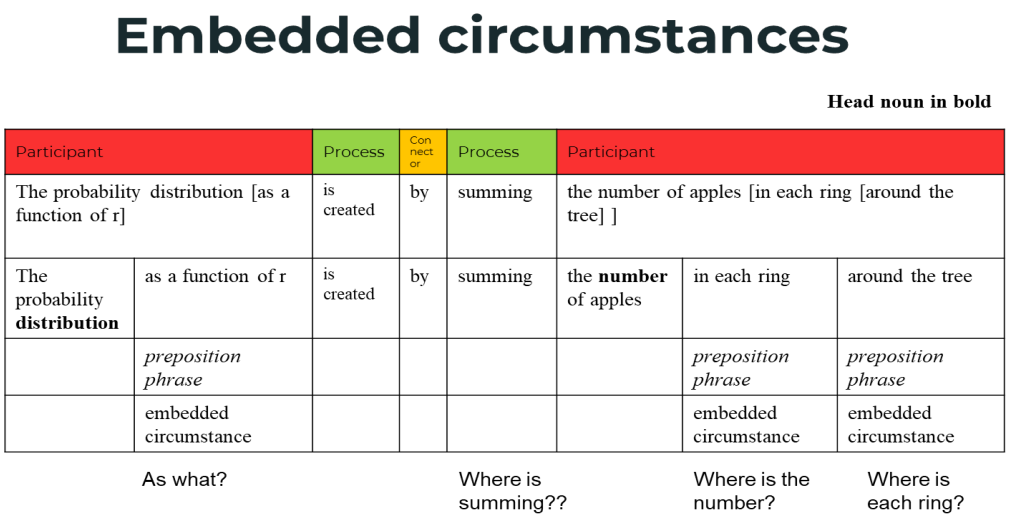


Figure 9

One of Three Pages of a Handout Adding Science Textbook Examples to a Table from J. R. Martin et al. (2010, pp. 101–102)

Type	Probe question	Subcategory	Probe question	Short examples	Science textbook examples: Physics | Calculus | Chemistry
Extent	how ___ ? at what intervals?	**duration frequency**	for how long? how many times?	for three hours every three hours	• The film runs **for about 2 hours** • the horizontal line intersects the graph infinitely **many times**.
		distance	how far	for six miles	• the bus must have travelled **between 80 x 1.5 = 120 and 120 x 1.5 = 180km** during the film • For example, we can say that there is a 90% chance that the electron will be **within a certain distance from the nucleus.**
Location	at what point?	**time**	when?	in September; before tea; recently; during the lesson	• **Last week**, we discussed the normal force, • In circular motion, we are changing direction **all the time**. • Whenever we observe a quantum particle, we will **always** see it as a particle in a well-defined location.
		place	where?	in the yard; from Paris; miles away	• We follow **here** the basics of problem solving presented earlier in this text. • Note that no internal forces are shown **in a free-body diagram.** • $F^{\rightarrow}_{T}$ acts **on the outside world** • this choice of base works very nicely **in calculus** • Whenever we observe a quantum particle, we will always see it as a particle **in a well-defined location**.
Manner	how?	**means**	by what means?	with a hammer; by trickery	• **with experience**, it becomes progressively easier to judge whether an answer is reasonable • the forces can be handled **algebraically** • This time, **from a knowledge of the instantaneous rate of change of position — the derivative — throughout a 90 minute time interval**, we are able to say something about the net change of position during the 90 minutes • Assume there is one runner on the track at a time and the runner selects a lane **at random**. • … if the lines separating the lanes were washed away **by rain**. • Unlike classical particles, we cannot predict, **with certainty**, where a quantum particle will be in the next moment, even if we know here it is now.
		quality	how?	quickly	• it is best to label these arrows **carefully** • **Briefly** explain your ranking here • Since this choice of base • works so **cleanly** and **easily** with respect to differentiation • this choice of base works **very nicely** in calculus • **Comparatively**, graph (a) is wider than (b) and (c).

Unit 3: Grammar for Science

The third unit concludes the first term by combining and reframing the first two units, introducing the concept of logical grammatical metaphor to articulate the similarities and differences between the grammatical features. Investigating both logical meanings (with clauses) as well as circumstances at the same time allows students to identify key technicality and detail that may be expressed in both forms. Figure 10 provides an example of parallel analysis, with prompts for more critical interpretation of the language used in the excerpts. It also calculates the grammatical intricacy (number of clauses divided by the number of sentences) to prompt discussion around lower grammatical intricacies being associated with academic writing; therefore, the impact of the higher number of circumstances per clause shows shifting clauses into circumstances may make a text "more academic." Grammatical metaphor, or the notion that ideas that may be congruently expressed in one grammatical form may be metaphorically expressed in another form, helps to bring these two concepts together. For example, the logical concept of cause may be expressed with a dependent clause beginning with "because" or "as" or condensed in a circumstance of cause, with a prepositional phrase beginning with "due to" or "because of." As students have learned about nominalization (the transformation of verbs and adjectives into nouns) as another form of grammatical metaphor in their concurrent class, this perspective of language as potential and choice is reinforced. In this unit, even greater emphasis is given to the scientific meanings expressed through grammar and the choices made by the textbook writers and instructors for the students for the purpose of learning about science and assessing their knowledge.

Figure 10

Analysis of Circumstances and Logic in a Chemistry Excerpt, with Prompts for Discussion

- Is the grammatical intricacy low and academic (closer to 1) or high and non-academic (above 2)?
- What forms of connectors are used? Conjunctions or connectives?
- What types of logic is used?
- What types of circumstances are used?

Clause	Sentence	Circumstance types	Logic types
1	Up to this point, we have only considered the microscopic properties of individual chemical species (***i.e.***, shape, bond angle, and bond order).	Location: place/time	(= Elaborating exposition)
2	In the real world, chemicals are not found as single atoms, molecules, and ions.	Location place Role: guise	
3	***For example***, a can of pop contains approximately 1025 molecules of H2O, ***which*** are held together by attractive forces ***that*** keep the water as a liquid at room temperature.	Manner: means Role: guise Contingency: condition	= Elaborating: exemplification, clarification x2
4	In the bulk state, many of the macroscopic properties of chemical substances are governed by interatomic and intermolecular forces (***i.e.***, the forces between individual atoms, molecules and/or ions).	Contingency: condition Manner: means Location: place	(= Elaborating exposition)
5-6	In the case of a can of pop, each water molecule interacts with, || ***and*** influences, the orientation of adjacent water molecules.	Contingency: condition	+ Extending: addition
7	***In addition***, the water molecules interact with molecules of sugar, ions from dissolved salts, the dissolved carbon dioxide, and other chemicals.	Location: place	+ Extending: addition
8	The combination of these forces gives rise to the properties of the solution as a whole.	Extent: degree	

Circumstances: 12/7 = 1.71

Grammatical intricacy: 8/7 = 1.14

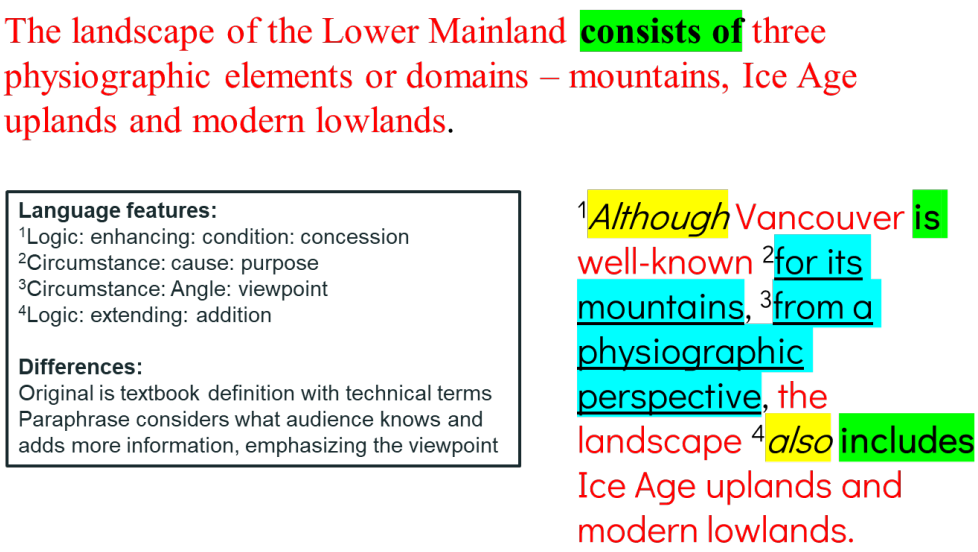
Unit 4: Repositioning in Writing

The fourth unit shifts the focus from grammatical concepts primarily for reading to those for writing. At the start of the second term, transitivity, logic, and circumstances are revisited and grammatical metaphor reintroduced as a strategic way to paraphrase and reposition sources, and referencing conventions and citation are introduced. This unit was substantively informed by the work of writers like Walsh Marr (2019), who highlighted the usefulness of grammatical metaphor for paraphrasing, and Liardét (2013, 2016, 2018), who focused particularly on interpersonal grammatical metaphor and engagement in a data set of Chinese student writing. Simpson-Smith's (2021, 2022, 2023, 2024) exploration of appraisal in both student and professional engineering texts also validated attention to the interpersonal metafunction and provided productive insights on when different patterns are deployed. Figure 11 shows a simple activity paraphrasing a basic definition about Vancouver geography using language features covered in the previous term, demonstrating their purposeful use in writing.

As students had their first argumentative essay for a concurrent course due halfway through the term, it was helpful to introduce concepts from the interpersonal metafunction of SFL, which deals with

Figure 11

Slide Paraphrasing of a Simple Definition from a Geology Textbook



the construction of relationships and particularly includes elements relating to persuasive and argumentative writing. Appraisal (J. R. Martin & White, 2005) was selected as the framework, as it operates at a more abstract level and works across grammatical categories. Multiple studies have demonstrated the relevance of the appraisal framework for student writing and in professional writing (Liardét, 2013, 2018; Simpson-Smith, 2021, 2024). Specifically, engagement (White, 2012) was introduced with the notions of expanding dialogic space (through implying or evoking possibilities, or attribution) or contracting dialogic space (through negating, limiting, or emphasizing possibilities). These concepts therefore layer more meanings on more grammatical forms and elaborate on prior functions, such as exploring how the modality of a modal finite (*can*) may also be expressed as a modal adverb (*possibly*) or noun (*possibility*); or examining

how projecting logic (*scientist states that …*) can be used interpersonally to position claims emphatically (*research proves that …*) or distantly (*findings suggest that …*).

This provided a framework for encouraging students to use more expansive language to propose claims and offer evidence, rather than emphasizing claims and relying on the authority of expert scientists. One simple successful activity is illustrated in Table 3: in groups, students were prompted to give an original statement that other students then had to reframe using engagement resources. The simple examples developed skills for positioning claims based on the available evidence in their argumentative writing.

Table 3

Engagement Repositioning Activity Example

Prompt	Science facts	Things parents say	Something you'd say to an animal/pet/baby	After the pandemic
Original statement	The sky is blue	Speak slowly and enunciate clearly!	Do you need to poo?	I will hug everyone!
Entertain	It is possible that the sky may be sometimes blue.	You should definitely always speak slowly and enunciate clearly.	The dog urgently desperately immediately must poo!	I suggest hugging everyone carefully.
Attribute	The meteorologist reported that the sky was blue.	According to my dad, I should speak slowly and enunciate clearly.	He asked whether the dog needed to poo.	Bonnie Henry says hugs are permitted.
Disclaim	Although the sky is blue, it is not right now. It is cloudy.	Don't speak slowly! Never enunciate clearly!	However, the dog did not reply.	I will never hug or shake hands ever again.
Proclaim	I insist that the sky is blue!	Research demonstrates that people understand you better if you speak slowly.	Of course I need to poo!	Figure 1 demonstrates an increased rate of embracing.

Unit 5: Presentations

The final unit of this course focused on presentations and again repurposed the same grammatical concepts in speech and slide text, adding multimodal formats (speech, image, text) and intermodal logical relations (images and speech). This unit has been detailed at length in J. L. Martin (2023), and the use of reflective writing explored in J. L. Martin (2024), so I will not elaborate in full here. However, Table 4 shows how engagement resources from Liardét (2014) that were introduced in the previous unit could then be used differently in different presentation formats in comparison to academic writing. Figure 12 shows how logical relations first detailed in unit 2 were used to articulate intersemiotic relationships between images and speech inspired by Roehrich (2016) and following Scott (2022).

Together, the five substantive units of this course go in depth into selected grammatical forms specifically chosen to connect together, provide reading, writing, and presenting insights and strategies, and both complement the concurrent academic English writing courses and support the concurrent science courses.

Table 4

Suggested Use of Engagement Resources in PechaKucha[a] (PK), Academic Presentations (AP) and Academic Writing (AW)

Engagement	Subjective/objective	Grammar	Example	PK	AP	AW
Contract	Subjective	Circumstance	From all of our experiences,	✓	✓	
		Projecting clause	We all know that…	✓	✓	
	Objective	Circumstance	From everybody's experience	✓	✓	
		Projecting clause	It is known to all that…	✓	✓	
Expand	Subjective	Circumstance	In my opinion,	✓	✓	
		Projecting clause	I believe that…	✓	✓	
	Objective	Circumstance	In all probability…		✓	✓
		Projecting clause	It is possible that…		✓	✓
		Participant	The possibility of…			✓

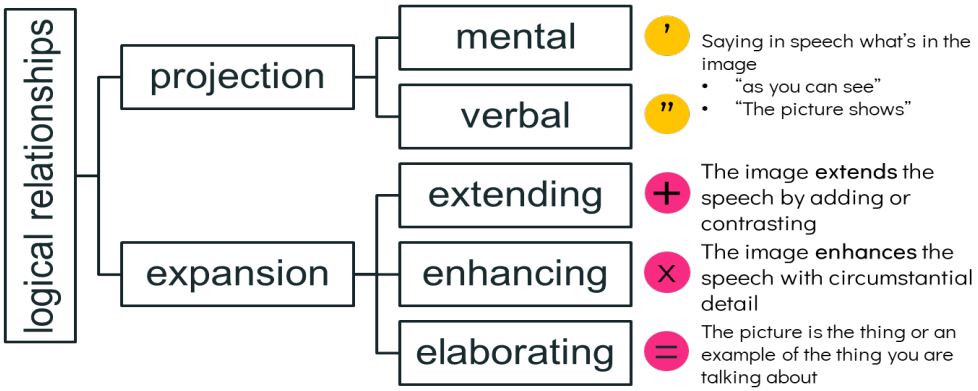
[a] PechaKucha is form of presentation that focuses on visual images and storytelling through strictly timed slide progression. Its strict structure has turned out to be pedagogically invaluable in teaching students presentation skills. See J. L. Martin (2023) for more on its usefulness, curriculum design, and assessment.
Note. Adapted from Liardét (2014, p. 105)

Conclusion

This article has described a grammar-focused curriculum that strategically selects and sequences grammatical concepts, activities, and assessments for a practical and transferrable language awareness in first-year science students. While formal evaluation or research has not been possible, qualitative evidence does provide some measure of validation.

Figure 12

Slide Relating Types of Logical Relations to Intersemiotic Meanings



Note. Adapted from Roehrich (2016)

First, this curriculum has been adopted and tested voluntarily by other EAP instructors who have moved into the science program in recent years. That is, while we have autonomy over our curricula, they similarly identified certain needs and adapted units from my curriculum to their own expertise and comfort level, for example by using different concepts within the repositioning unit or by incorporating a written assessment instead of the grammar discussion. This suggests that the success of the design is not predicated solely on my educational background with a PhD in SFL, nor on my particular personality and skills as a teacher. Further, they have reported the advantages of this curriculum not only in teaching this specific course but also in its compatibility with and transferability to the concurrent writing-focused course. While most contexts would be lucky to have one academic English course let alone two simultaneous ones, it is important to remember that the advantage of consistent metalanguage is that it enables knowledge transfer between courses and contexts.

Second, students reported increased confidence with a range of language use thanks to the concepts in the course. This includes the intended outcomes of being able to make sense of a complex passage in a textbook, or to efficiently identify key variables in a word problem during an exam, or to strategically construct an argument in writing an essay or scripting a presentation. They have further reported unintended benefits, like being able to read more quickly with their increased awareness of structure. The annual student evaluations of instruction have been consistently positive over the years, with high responses to the relevance of the course. I would argue that this response is because useful concepts were selected for instruction, their usefulness explained and demonstrated, and finally the students experienced how useful those concepts were through practical experience. Grammatical instruction in academic contexts has often risked a rarefied, decontextualized approach: embracing practical complexity must be the response.

Teaching language with grammar involves incorporating concepts that have the maximum explanatory potential for most language use and multiple encounters with real, messy, and authentic language. I hope this article has provided some measure of demonstration about how this can be done, and about the power of grammar for science.

The Author

Jodie Martin is currently an independent scholar searching for her next opportunity to solve language problems and present interesting solutions in engaging formats. She has published on her seven years of teaching in Vancouver, Canada, through the lenses of systemic functional linguistics and Legitimation Code Theory in order to figure out how it worked, and to share interesting applications of and developments in theory, curriculum and assessment design. Her philosophy of teaching is "responsive and responsible pedagogy," whereby she responds to the students in each and every class, while taking responsibility for the content, values, and pedagogy she brings to each class. She has a PhD in linguistics, with a focus on academic writing, from the University of Adelaide, Australia, and previously worked in linguistic, educational, and sociological research, teaching, and research administration in Sydney, Australia.

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Appendix: Further Reading on Systemic Functional Linguistics and Its Classroom Applications

In addition to the sources cited throughout this article, the following sources are written by both theorists and practitioners, all actively engaged in education, and provide examples and explanations for both new and experienced teachers.

Books:

These books provide examples, teaching materials, pedagogical metalanguage, and more based on work with teachers in the United States and Australia.

Brisk, M. E. (2023). *Engaging students in academic literacies: SFL genre pedagogy for K–8 classrooms* (2nd ed.). Routledge. https://doi.org/10.4324/9781003329275

De Oliveira, L. C. (2023). *Supporting multilingual learners' academic language development: A language-based approach to content instruction*. Routledge. https://doi.org/10.4324/9781003264927

Derewianka, B., & Jones, P. (2023). *Teaching language in context* (3rd ed.). Oxford University Press.

Rose, D., & Martin, J. R. (2012). *Learning to write, reading to learn*. Equinox Publishing.

Book chapter:

This book chapter describes three "hero" concepts of SFL, highlighting how they address common issues in writing by responding to vague feedback. It was written by an instructor in the same program in Canada as the author of this article.

Walsh Marr, J. (2021). Moving from form to function: Leveraging SFL metalanguage to illuminate features and functions of texts in first-year university EAP. In C. MacDiarmid & J. J. MacDonald

(Eds.), *Pedagogies in English for academic purposes: Teaching and learning in international contexts* (pp. 43–58). Bloomsbury Academic.

Blogs:

At the time of writing, these sources are actively maintained by their authors in the United Kingdom and the United States, respectively, and provide an accessible introduction to SFL concepts. They also compile and share other useful resources.

Monbec, L. (2022, June 29). *Systemic functional linguistics for the self-taught: Part 1.* BALEAP Research and Publications website. https://research.baleap.org/2022/06/29/systemic-functional-linguistics-for-the-self-taught-part-1/

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