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Unlocking Science: Morphology in the Intermediate Years.

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Abstract

This study investigates how intermediate teachers in Aotearoa New Zealand currently teach scientific texts and their understanding of morphology as a strategy to support vocabulary acquisition. Morphological awareness, the ability to consciously analyse and use meaningful word parts, has been linked to vocabulary growth and comprehension. However, its role in science instruction remains underexplored. To gain an understanding of this problem, semi-structured interviews with four intermediate and science teachers were analysed using reflexive thematic analysis. The five themes that emerged include the following:

1. Gaps in discipline-specific vocabulary limit students' ability to express scientific understanding
2. Science vocabulary instruction is informal, variable, and lacks system-wide consistency
3. Teachers show limited understanding of morphology and use it only incidentally
4. Teachers want practical, science-aligned morphology instruction with clear examples and support
5. Structural constraints and disciplinary perceptions limit literacy integration in science.

Findings indicate that while participants value vocabulary instruction to support comprehension, they lack systematic strategies to embed morphology into their classroom instruction. Drawing on analysis of participant interviews and existing research, a framework is proposed that integrates student routines and teacher professional development to reduce cognitive barriers and promote equitable access to the language of science. This study demonstrates how morphology can be embedded to strengthen both literacy and science learning within Aotearoa New Zealand's intermediate-level classrooms.

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Chapter 1: Introduction

1.1 Background and Rationale

Literacy achievement rates in Aotearoa New Zealand have been a persistent national concern, with successive governments acknowledging ongoing declines in performance (OECD, 2023a). International assessments, such as the Programme for International Student Assessment (PISA), indicate that although performance in reading and science has been relatively stable since 2018, current results remain lower than in previous years (OECD, 2023a). These continuing trends raise questions about whether students are adequately prepared for the linguistic demands of secondary schooling.

Within this broader context, science presents a dual challenge for students. They must navigate specialised language alongside complex concepts. Scientific texts are dense and abstract, and they contain large amounts of multimorphemic vocabulary (Snow, 2010). For many learners, particularly those acquiring English as an additional language or those with weaker literacy foundations, these texts can limit opportunities to demonstrate conceptual understanding (Wellington & Osborne, 2001). This barrier can persist even when students have grasped the underlying scientific ideas (Fang, 2006; Snow, 2010). When this occurs, the linguistic complexity of scientific language can obscure what students know (Fang, 2008). As a result, students' understanding is not always visible in assessment or during classroom discourse (Snow & Uccelli, 2009; Wellington & Osborne, 2001).

As these difficulties often arise from the structure of scientific vocabulary, a focus on word formation offers a promising way to reduce language barriers. Morphology, the study of how words are constructed from meaningful units, can support students in accessing specialised scientific terminology and interpret unfamiliar words more effectively. Research indicates that morphological awareness supports vocabulary development and reading comprehension (Carlisle, 2000). Despite

this relevance, morphology is not consistently or systematically integrated into science instruction, and its potential to support access to scientific language remains underutilised (Reed, 2008). This gap between the linguistic demands of science and instructional practice strengthens the case for investigating how morphology might be more effectively embedded within science teaching.

1.2 Research Problem

Teachers of Year 7 and 8 (students aged 11–13) in Aotearoa New Zealand play a pivotal role in supporting students' vocabulary development as they transition to secondary schooling. Yet little is known about how these teachers understand morphology or how they view its place within science learning. Without their perspectives, morphology risks remaining peripheral to classroom practice rather than becoming an integrated component of science instruction. This study therefore seeks to address the gap between the linguistic demands of science and the literacy support currently available to students.

To investigate this problem, this study adopted a qualitative design. Semi-structured interviews were conducted with four teachers experienced in both intermediate and science teaching, and the resulting data were analysed using reflexive thematic analysis (Braun & Clarke, 2019). This approach foregrounds teachers' accounts, enabling inductively generated patterns to be interpreted through relevant theoretical lenses. The study is guided by a research aim and four questions.

Research Aim

This study aims to investigate how Year 7 and 8 teachers in Aotearoa New Zealand understand and apply morphology-based instruction within science teaching, and to identify the conditions and supports required to enable Cognitive Load Theory (CLT) -aligned implementation that is both feasible and sustainable in classroom practice.

Research Questions

1. How do Year 7 and 8 teachers conceptualise morphology and its role in science literacy?
2. In what ways do teachers currently integrate morphology-based instruction in science?
3. What conditions enable or constrain the use of morphology-based instruction in science?
4. From teachers' perspectives, what instructional design principles and supports are needed to develop and implement a morphology-based programme that is feasible, sustainable, and CLT-aligned in Year 7 and 8 science?

1.3 Significance of the Study

This study is significant in three ways. Firstly, although morphological awareness has been widely examined in general literacy contexts, far less attention has been given to its role within science education. This gap is notable because scientific vocabulary is heavily dependent on multimorphemic terminology, placing substantial linguistic demands on learners (Nagy & Townsend, 2012). By focusing specifically on morphology in science, this study addresses an underexplored area of research and highlights the potential of explicit morphological instruction to support students in reading, understanding, and articulating scientific concepts.

Secondly, the study emphasises teacher perspectives on science vocabulary and morphology. A substantial body of research highlights the benefits of morphological awareness for students' comprehension and word learning (e.g., Bowers et al., 2010; Carlisle, 2000), yet far less is known about how teachers conceptualise and apply this knowledge in practice. Sustainable literacy improvement requires strengthening not only student-focused interventions but also teacher knowledge, beliefs, and instructional decision-making (Moats, 2020; Shanahan & Shanahan, 2008). By presenting the voices of intermediate teachers, the study identifies both opportunities and barriers to integrating morphology meaningfully into science classrooms.

Finally, this study connects teacher perspectives with theoretical insights from reading and cognitive science. These frameworks offer complementary explanations of how morphology

contributes to vocabulary development and comprehension. The Simple View of Reading (Gough & Tunmer, 1986), Ehri's (1995) theory of orthographic mapping, Share's (1995) self-teaching hypothesis, the Cognitive Foundations Framework (Tunmer & Hoover, 2019), and Cognitive Load Theory (Sweller, 1988) each illuminate different aspects of how students learn complex words. Drawing these perspectives together, the study proposes principles for a morphology-based programme that reduces cognitive load and equips teachers with strategies that are both pedagogically robust and practical to implement.

1.4 Structure of the Thesis

The thesis is organised into five chapters. Chapter 1 introduces the study and outlines the background, research problem, rationale, and significance. Chapter 2 reviews the relevant literature on reading development, morphological structure and function, disciplinary literacy in science, and cognitive load. It also presents the Aotearoa New Zealand educational context, the researcher's background and positionality, and concludes with the research aim and questions that guide the study. Chapter 3 outlines the methodological approach, detailing the research design, ethical procedures, data collection, and use of reflexive thematic analysis to interpret teacher interviews. Chapter 4 presents the findings, organised into five themes that capture teacher perspectives on scientific vocabulary, morphology, instructional practices, and systemic constraints. Chapter 5 discusses the findings in relation to existing research and theoretical frameworks, answers the research questions, and identifies implications for practice, policy, and future research, while also acknowledging the study's limitations.

Chapter 2: Literature Review

Research consistently demonstrates that proficient reading supports students' academic achievement across the curriculum. For example, Bayat et al. (2014) found that strong reading comprehension skills support the acquisition of complex ideas and new information, enabling students to engage more effectively with learning in multiple subject areas. This pattern is reinforced by broader evidence. A recent systematic review of 27 peer-reviewed studies published between 2000 and 2024 reported a consistent positive correlation between reading proficiency and academic achievement across diverse disciplines (Mihret & Joshi, 2025). In this review, stronger readers were better able to navigate challenging content, whereas their less proficient peers struggled to interpret discipline-specific material.

The relationship between reading comprehension and academic success is especially important in science. Students with strong comprehension skills can draw inferences and apply reading strategies to compensate for limited background knowledge. In contrast, weaker readers often experience difficulty constructing meaning and may disengage from tasks altogether (O'Reilly & McNamara, 2007). These challenges intensify in science because texts contain specialised linguistic and conceptual demands. Scientific writing requires the interpretation of technical vocabulary, symbolic representations, and dense informational structures (Lee et al., 2013; Snow, 2010). The prevalence of multimorphemic terminology derived from Latin and Greek roots further complicates reading, creating barriers even for otherwise proficient readers (Kieffer & Lesaux, 2012; Nagy & Townsend, 2012). This level of linguistic complexity increases cognitive load and risks overloading working memory during comprehension (Sweller, 1988).

Morphological awareness offers a potential response to these challenges. Correlational studies indicate that higher levels of morphological awareness are associated with stronger reading comprehension among both native English speakers and English language learners (Carlisle, 2000; Nagy et al., 2006). This relationship remains significant even after accounting for vocabulary

knowledge and word reading skills (Kieffer & Lesaux, 2007). Research across varied populations also shows that morphological awareness contributes to comprehension directly and indirectly through its role in vocabulary development (Kieffer & Lesaux, 2012). Intervention research strengthens this evidence. Studies demonstrate that morphology-based instruction can improve multiple literacy outcomes, producing moderate but meaningful gains in vocabulary (Goodwin & Ahn, 2010). These gains matter because vocabulary develops gradually and gaps tend to widen over time (Biemiller & Slonim, 2001). Even small improvements can support later comprehension and contribute to broader academic achievement (Snow et al., 2009).

These works show the central role of reading proficiency and the importance of morphological knowledge for understanding scientific language. This provides the foundation for the structure of the present chapter. After briefly outlining the researcher's background and positionality, the chapter reviews key theories of reading, including the Simple View of Reading (Gough & Tunmer, 1986), the Cognitive Foundations Framework (Tunmer & Hoover, 2019), Ehri's (1995) phase model of word reading development, and Share's (1995) self-teaching hypothesis. It then examines the structure and development of morphology and its contribution to vocabulary learning and comprehension. Particular attention is given to its importance for accessing the technical language of science. The chapter also introduces Cognitive Load Theory (Sweller, 1988) to explain how the linguistic complexity of science texts interacts with the limits of working memory and how instructional design can reduce these demands. It concludes by situating these issues within the Aotearoa New Zealand context, drawing on national achievement patterns, curriculum expectations, and teacher preparation to identify the research gap and refine the study's research questions.

2.1 Researcher Background and Positionality

My professional experience as a Year 8 teacher in Aotearoa New Zealand has strongly shaped the direction and focus of this study. However, the seeds for this research were planted much earlier. As a young teenager, I became severely unwell and missed several months of school. Returning to the classroom without adequate support introduced a challenge I had not faced before. Although I had once been a fluent decoder with a strong vocabulary that helped me navigate every day and fictional texts, the discipline-specific language now placed in front of me felt unfamiliar and overwhelming. I could no longer rely on general word knowledge to make sense of content, and having missed so much schooling, I struggled to understand the new information presented across subjects. At times, it felt as though lessons were being taught in a foreign language. Eventually, I left school with no formal qualification.

Entering university as an adult student, these difficulties resurfaced. I spent disproportionate amounts of time trying to untangle complex language, leaving little capacity for deeper comprehension. My early attempts at tertiary study were marked by inefficient habits that focused on getting through the readings rather than engaging critically with them. Although I succeeded academically, the effort required gave me a tangible understanding of the barriers that discipline-specific language can create.

My teacher training marked a turning point. Determined to support my future students more effectively than I had been supported, I searched for new ways of learning. I explored research on reading, experimented with strategies for analysing information, and developed practices that enabled me to learn more efficiently. These experiences built both empathy for students who face linguistic obstacles and a conviction that explicit language instruction can transform educational outcomes.

These convictions became even stronger in the classroom. Each year, I observed students struggling with the linguistic demands of discipline-specific texts, particularly in science. Although science often sparks curiosity and enthusiasm, many students lose confidence when they cannot fully interpret the concepts described in readings and lessons. The difficulty is more than brief confusion. It can lead to frustration, disengagement, and a growing belief that they are incapable learners. These observations align with wider concerns about whether students are adequately supported to navigate the academic language required for success across the curriculum.

Sedita (2024) notes that discipline-specific reading involves understanding vocabulary, text structures, and reasoning unique to each discipline. My classroom experience reflects this reality. Some students who read everyday texts fluently struggle with the technical language of science. They often rely on surface-level strategies such as repeated reading rather than deeper comprehension processes. Others resemble the patterns described by O'Reilly and McNamara (2007), whose research shows that difficulty comprehending complex texts can limit success even when learners are interested in the practical aspects of science. These students are not statistics. They are curious, capable learners who want to understand their world but are held back by language that feels impenetrable. I have seen their struggles in many forms. These include the quiet disengagement of a student who withdraws from the text, the tears of frustration after repeated attempts to understand a passage, the anger when effort is met with poor results, and the resignation of students who enjoy hands-on science but believe they will never grasp its language.

These factors shaped my initial vision for this research. I wanted to create a targeted programme that would explicitly teach morphology within science, enabling students to break down and analyse complex terms. I imagined instruction that would help struggling readers build confidence, transform moments of confusion into clarity, and support students to articulate their

scientific understanding more fully. My goal was for the language of science to become a tool for learning rather than a barrier.

However, school approval for an intervention could not be secured, and the study required a shift in direction. Although letting go of the opportunity to trial a programme with my own students was difficult, the change also opened an important pathway. Instead of implementing a programme, the study turned toward investigating teacher perspectives on morphology and science vocabulary. This shift allowed the research to stay focused on the linguistic challenges of science while broadening its scope. By foregrounding teacher voices, the study can inform the future development of a morphology-based programme that is sustainable, realistic, and relevant across intermediate classrooms rather than limited to a single setting. In this way, the study reflects both my personal experience as a practitioner and my interpretivist stance as a researcher. Meaningful educational change begins with understanding the perspectives of those working most closely with learners.

2.2 Reading Theories

2.2.1 The Simple View of Reading

The Simple View of Reading (SVR), developed by Gough and Tunmer (1986), proposes that reading comprehension (R) is the product of two components, word recognition (decoding) (D) and language comprehension (C). Hoover and Gough (1990) later formalised this relationship as $R = D \times C$. In the SVR formulation, decoding and language comprehension are conceptualised as ranging from 0 (no proficiency) to 1 (full proficiency) (Hoover & Tunmer, 2020). Because the model is multiplicative, weaknesses in either component sharply reduce overall comprehension (Hoover & Tunmer, 2020). For example, a student with moderate proficiency in word recognition (0.7) and language comprehension (0.6) would achieve a combined comprehension score of 0.42, demonstrating how partial development in both areas results in substantially reduced understanding.

Word recognition refers to the ability to translate written forms into spoken language efficiently and accurately (Hoover & Tunmer, 2020). This capacity develops through phonics, knowledge of letter-sound correspondences, and increasing automaticity with familiar words (Nation, 2019). Language comprehension encompasses vocabulary knowledge, syntactic and grammatical understanding, inferencing, and the integration of information across sentences and discourse (Hoover, 2023). These components form the basis of skilled reading, with growth in each contributing uniquely to overall comprehension (Perfetti & Stafura, 2014).

The SVR is supported by extensive empirical evidence. Lonigan et al. (2000) found that early word-recognition skills, including phonological sensitivity and letter knowledge, explained a substantial proportion of variance in early reading outcomes. Later longitudinal work demonstrated the model's robustness: Lonigan et al. (2018) showed that word recognition and language comprehension together accounted for 94-100% of variance in reading comprehension among children aged 8-11. Hjetland et al. (2019) similarly reported that, by age seven, these components explained nearly all variance in reading comprehension in a six-year study. Collectively, this evidence underscores the SVR's value as a powerful, empirically validated explanation of individual differences in reading development.

Beyond describing how comprehension develops, the SVR offers a practical framework for identifying distinct reading profiles (Gough & Tunmer, 1986; Hoover & Tunmer, 2020). Learners with strong language comprehension but weak word recognition typically align with dyslexia (Hoover & Tunmer, 2020). Those who recognise words accurately but struggle with vocabulary, inferencing, or broader language processes are often described as having a Specific Comprehension Difficulty (Nation, 2019). A third group presents weaknesses in both components, resulting in mixed reading difficulties (Hoover, 2023). These distinctions are instructionally relevant because they guide educators in matching teaching approaches to learner needs, whether through targeted instruction in word recognition, language comprehension, or both (Catts & Hogan, 2023).

2.2.2 The Cognitive Foundations Framework of Reading

While the SVR identifies the two broad components that produce reading comprehension, it does not explain the full range of underlying skills that support their development (Gough & Tunmer, 1986; Tunmer & Greaney, 2010). To address this limitation, Hoover and Tunmer (2019) introduced the Cognitive Foundations Framework (CFF), a more detailed model that outlines the cognitive and linguistic subskills contributing to both word recognition and language comprehension. The framework positions reading comprehension as the ultimate goal of reading and illustrates how it is supported by a set of interdependent foundational abilities (Hoover & Tunmer, 2019).

Within the language comprehension pathway, the CFF identifies a constellation of skills that extend well beyond vocabulary knowledge (Tunmer & Hoover, 2019). These include background knowledge, syntactic and semantic knowledge, morphological awareness, comprehension monitoring, and inference making (Nation, 2019; Perfetti & Stafura, 2014). Each skill contributes to readers' ability to interpret increasingly complex texts (Snow, 2010). Empirical research underscores their importance. For example, Oakhill and Cain (2012) found that inference making, comprehension monitoring, and knowledge of story structure predicted later reading comprehension even after earlier comprehension and vocabulary were controlled, supporting the CFF's emphasis on multiple interacting language processes.

In parallel, the word-recognition pathway in the CFF maps the development of skills required for accurate and automatic identification of written words (Tunmer & Hoover, 2019). These include print concepts, knowledge of letters, phonemic awareness, and mastery of the alphabetic principle (Moats, 2020). As individuals acquire letter–sound correspondences, they begin to decode unfamiliar words and build a growing repertoire of familiar word forms (Share, 1995). With repeated exposure and practice, orthographic mapping takes place, allowing readers to store connections between spellings, pronunciations, and meanings in long-term memory (Ehri, 2014).

Automatic word recognition is essential for fluent reading because it frees cognitive resources for higher-level comprehension (Perfetti & Stafura, 2014). By identifying the specific subskills that support word recognition and language comprehension, the CFF extends the SVR into a more comprehensive and instructionally useful account of reading development (Tunmer & Hoover, 2019).

2.2.3 Ehri's Phase Model

Ehri's Phase Model explains how learners develop skilled word recognition over time (Ehri, 1995, 2005). While the SVR and CFF identify the components and subskills required for proficient reading, about the developmental process of word recognition. (Gough & Tunmer, 1986; Tunmer & Greaney, 2010; Tunmer & Hoover, 2019). Ehri's model addresses this gap by outlining a sequence of phases through which readers typically progress as they move from early print awareness to automatic word reading (Ehri, 1995, 2005). Although framed as a progression, Ehri emphasises that development is not strictly linear (Ehri, 1998). Readers move flexibly between phases, drawing on earlier strategies even as more advanced ones become consolidated (Ehri, 2014). This developmental account aligns with the CFF's emphasis on the importance of accurate and automatic word recognition for supporting comprehension (Tunmer & Hoover, 2019; Moats, 2020).

The pre-alphabetic phase is characterised by reliance on visual and contextual cues rather than the alphabetic principle (Ehri, 1995). At this stage, children do not yet understand that letters represent speech sounds (Ehri, 2005). Instead, they identify familiar environmental print or symbols, such as recognising a stop sign or a brand logo, without attending to individual letters (Neuman & Roskos, 1993). Masonheimer et al. (1984) demonstrated this when children read Xepsi as Pepsi, indicating reliance on visual templates. Levin and Ehri (2009) reported similar findings among preschoolers who recognised peers' names only when attached to cubbies, not in isolation.

Although children are not yet decoding, this phase builds familiarity with print and establishes a foundation for later alphabetic learning (Lonigan et al., 2000).

In the partial alphabetic phase, children begin to understand that letters map onto sounds, but their knowledge is incomplete and inconsistently applied (Ehri, 1995, 2005). They often read words using only initial or final graphemes as anchors (Treiman, 1991). For example, a child may identify dog by noticing the d and g while ignoring the medial vowel. Research confirms that beginning readers attend more closely to boundary letters than to internal ones (Treiman & Kessler, 2014). These partial strategies are imperfect but serve as a bridge between visual-cue reading and full decoding (Castles et al., 2018; Ehri, 2014).

The full alphabetic phase marks a significant shift toward systematic decoding (Ehri, 1995; Share, 1995). Students apply grapheme–phoneme correspondences to blend and read unfamiliar words, drawing on a more complete understanding of the alphabetic principle (Ehri, 2020; Moats, 2020). Through repeated practice, many of the words they decode become stored in memory as “sight words,” recognised instantly without conscious analysis (Ehri, 2020). As sight-word vocabulary grows, cognitive resources become increasingly available for comprehension (Perfetti & Stafura, 2014).

In the consolidated alphabetic phase, readers begin to process larger, more familiar orthographic units, such as syllables, morphemes, and common spelling patterns (Ehri, 2014; Hoover & Tunmer, 2020). Instead of decoding jumped letter by letter, they recognise jump as a base word and -ed as a past-tense suffix (Moats, 2020). This ability to “chunk” print leads to greater automaticity and fluency, supporting more efficient comprehension (LaBerge & Samuels, 1974; Perfetti, 2007). Importantly, this phase lays the groundwork for morphological awareness, as students start to notice recurring morphemes that support both decoding and vocabulary growth (Carlisle, 2000).

Underlying these phases is the process of orthographic mapping, through which readers develop permanent connections between a word's spelling, pronunciation, and meaning (Ehri, 2014; Moats, 2020). Orthographic mapping allows familiar words to be recognised instantly and enables readers to build a robust mental lexicon. Rapid retrieval of known words reduces the cognitive demands of decoding (LaBerge & Samuels, 1974) and frees working memory for comprehension processes such as inference making and integrating ideas across texts (Perfetti, 2007). Over time, automaticity in word recognition becomes essential not only for fluent reading but also for vocabulary development and long-term reading success (Perfetti, 2007).

2.2.4 Share's Self-Teaching Hypothesis

While Ehri's Phase Model explains how readers progress from visual-cue reliance to automatic word recognition, it does not fully account for how children acquire the thousands of words required for fluent reading (Ehri, 1995, 2005). Share's (1995) Self-Teaching Hypothesis (STH) addresses this gap by proposing that phonological recoding acts as a self-teaching mechanism through which readers independently develop word-specific orthographic representations (Share, 1995, 1999). Phonological recoding, the process of translating graphemes into phonemes, enables learners to decode unfamiliar words (Harm & Seidenberg, 1999). Each successful decoding attempt creates an opportunity for orthographic learning without direct instruction, gradually strengthening the link between a word's spelling, pronunciation, and meaning in long-term memory (Ehri, 2014; Moats, 2020). As these representations accumulate, words become increasingly familiar and are recognised with minimal effort (Perfetti & Hart, 2001). This reduction in attentional demand allows cognitive resources to shift from decoding to comprehension and integration across texts (LaBerge & Samuels, 1974; Perfetti, 2007).

Experimental evidence supports this mechanism. Cunningham (2006) demonstrated that children could learn and later recognise the spellings of novel words after only a few independent

decoding attempts, indicating that even brief exposures have a durable orthographic impact. Share (1995, 2008) further argued that the majority of vocabulary growth results from this process, because learners encounter far more words through reading than can realistically be taught explicitly. Each encounter with print provides an opportunity to decode, strengthen orthographic representations, and expand the lexicon (Nagy et al., 1985). Over time, these small moments of learning accumulate into substantial vocabulary knowledge, helping explain how readers acquire large vocabularies with minimal direct instruction (Anderson & Nagy, 1992).

Self-teaching operates not only at the level of individual grapheme–phoneme correspondences but also across larger orthographic and morphological units (Share, 1995; Share, 1999). As learners decode words such as erosion or evaporation, they encode the full spelling pattern while also noticing recurring elements such as the suffix -ion (Nation, 2013). These recurring morphemic patterns become anchors that support future learning, making subsequent encounters with related words more efficient (Share, 2008). Research further shows that awareness of roots and affixes promotes generalisation across domains and supports comprehension of complex academic vocabulary (Carlisle, 2000; Nagy & Townsend, 2012). Contemporary reviews position the Self-Teaching Hypothesis as a central explanation for how readers build large and flexible vocabularies across alphabetic languages (Castles et al., 2018).

For the present study, Share’s self-teaching hypothesis (Share, 1995, 1999) is particularly relevant to the linguistic demands of science. Scientific vocabulary is typically morphologically complex, low frequency, and conceptually dense, characteristics that make exhaustive explicit teaching unrealistic (Nagy & Townsend, 2012; Snow, 2010; Wellington & Osborne, 2001). Within Share’s framework (Share, 1995, 1999), learners acquire many of these terms through independent reading, but only when they possess secure decoding skills and regular opportunities to encounter words in meaningful scientific contexts (Share, 1995, 1999). This mechanism highlights the importance of equipping students with explicit linguistic tools, including morpheme knowledge and

generative strategies, to support access to the specialised vocabulary that science requires (Bowers & Kirby, 2010; Kieffer & Lesaux, 2012; Moats, 2020).

2.3 The Structure and Function of Morphology in Literacy

Morphology provides a framework for understanding how words are organised and how their meanings are constructed from smaller components (Apel, 2014; Moats, 2020). A morpheme is the smallest unit of meaning in a language (Carlisle, 2010). Recognising these units enables readers to analyse complex words, identify relationships between word forms, and infer the meanings of unfamiliar vocabulary (Bowers et al., 2010; Moats, 2020). Because English contains a high proportion of multimorphemic words, especially in academic domains such as science, knowledge of word structure plays an important role in accurate word recognition and vocabulary learning (Moats, 2020). These relationships position morphology within broader models of reading. Both the Simple View of Reading (SVR) and the Cognitive Foundations Framework (CFF) argue that skilled reading depends on accurate word recognition and robust language comprehension. Morphology contributes to both through clarifying word form and expanding the vocabulary resources needed for comprehension (Share, 1995; Tunmer & Hoover, 2019). This section first outlines key morpheme types, then distinguishes inflectional from derivational processes, and finally explains the generative nature of morphological knowledge.

2.3.1 Types of Morphemes

A widely recognised distinction within morphology concerns the types of morphemes that make up English words (Moats, 2020). Free morphemes can stand alone as whole words and include content words such as *run* and *house*, as well as function words such as *but* and *on* (Moats, 2020). Bound morphemes must attach to a base to convey meaning and include prefixes such as *un-* in *undo* and suffixes such as *-ed* in *walked* (Moats, 2020). The central unit of a multimorphemic word is the base, which carries the word's core meaning. In linguistic descriptions this unit may be labelled a root or a stem (Aronoff & Fudeman, 2011), but in educational contexts the term base

word is often used to describe forms that can stand alone (Moats, 2020). For example, in unhappiness, the base happy provides the central meaning, while un adds negation and ness forms a noun.

2.3.2 Inflectional and Derivational Morphology

Morphological structure also distinguishes between inflectional and derivational processes (Apel et al., 2012). Inflectional morphemes express grammatical features such as tense or number without changing a word's class (Apel et al., 2012). For example, dogs uses the inflectional suffix s to mark plural number, while jumped uses ed to mark past tense. Derivational morphemes create new lexical items or shift grammatical category, such as teach becoming teacher (Apel et al., 2012). Derivations vary in transparency. Some preserve clear relationships between the base and derivative, such as friend and friendship (Carlisle & Stone, 2005), while others involve shifts in sound, spelling, or meaning that obscure underlying structure, as in steal and stealth (McCutchen et al., 2008).

2.3.3 Generative Morphological Knowledge

Morphological knowledge is generative rather than merely descriptive, because recognising bases and affixes enables learners to infer the meanings of unfamiliar but related words (Bowers & Kirby, 2010; Nagy & Anderson, 1984). Large portions of English vocabulary belong to morphological families, meaning that new words can often be understood by recognising familiar bases and affixes (Nagy & Anderson, 1984). Empirical research supports this generative function. Bowers and Kirby (2010) found that explicit teaching of word families enabled students to transfer structural knowledge to unfamiliar derivatives. Similarly, a synthesis by Bowers et al. (2010) showed that explicit morphological instruction improves vocabulary, decoding, and comprehension, particularly when integrated with broader literacy teaching. These findings suggest that morphological knowledge offers an efficient pathway for expanding academic vocabulary.

2.4 Development of Morphological Awareness

Morphological awareness refers to the ability to recognise, reflect on, and manipulate meaningful units within words (Carlisle, 2000). It develops gradually and becomes increasingly important for comprehension as texts grow more linguistically demanding (Carlisle, 2000, 2003). Beginning readers initially rely primarily on phonological decoding to identify unfamiliar words (Carlisle, 2000). As they progress through schooling, however, morphological awareness begins to play a stronger role in vocabulary growth and comprehension, particularly in subjects where multimorphemic terminology is common (Carlisle, 2003; Nagy et al., 2006).

Exposure to a wider range of academic texts gives learners opportunities to notice recurring patterns across related words, but this exposure alone is insufficient for developing the deeper morphological knowledge required for skilled reading (Bowers & Kirby, 2010). Morphological knowledge involves understanding how morphemes function and combine, including bases, affixes, spelling patterns, and semantic or grammatical relationships between word forms (Apel, 2014). Research shows that such knowledge does not reliably develop through incidental encounters with print; explicit opportunities to analyse word structure are needed for most learners (Goodwin & Ahn, 2013).

Empirical studies confirm this developmental trajectory. Carlisle (2003) found that students who could accurately manipulate derived word forms demonstrated stronger reading comprehension, even after controlling for vocabulary and decoding. Nagy et al. (2006) extended these findings across primary, intermediate, and secondary students, showing that morphological awareness becomes an increasingly powerful predictor of comprehension as texts grow richer in morphologically complex vocabulary. These developmental patterns demonstrate the role of morphological awareness as a contributor to reading comprehension, as discussed in the following section.

2.5 Morphological Awareness and Reading Comprehension

Morphological awareness supports reading comprehension by helping readers move beyond basic word recognition toward more efficient vocabulary growth and flexible meaning-making (Carlisle, 2010; Kieffer & Lesaux, 2012). Defined as the ability to analyse and manipulate meaningful parts of complex words, morphological awareness provides strategies for identifying unfamiliar forms and constructing meaning from their components (Carlisle, 2010). In an integrative review of 16 studies, Carlisle (2010) found that morphological awareness contributes to vocabulary learning and comprehension, particularly when instruction links spelling, structure, and meaning.

One mechanism through which morphology supports comprehension is vocabulary growth, as morphological awareness enables readers to infer the meanings of unfamiliar words by analysing their constituent morphemes (Carlisle, 2010; Nagy & Anderson, 1984). Because large portions of English vocabulary belong to morphological families, readers can use familiar bases and affixes to infer related but unfamiliar words (Bowers & Kirby, 2010; Nagy & Anderson, 1984). This generative learning is especially valuable in academic subjects, where vocabulary is dense and conceptually demanding (Nagy & Townsend, 2012). Recognising morphological relationships strengthens semantic networks, enhancing students' ability to integrate new concepts and understand texts (Kieffer & Lesaux, 2012).

Morphological awareness also supports comprehension at the syntactic level (Carlisle, 2010). Inflectional morphemes such as tense or comparison markers signal how words function within sentences, helping readers interpret complex academic syntax (Kuo & Anderson, 2006). Apel (2014) argues that morphological awareness encompasses both identifying morphemes and understanding the rules governing how they combine. Students with stronger morphological awareness demonstrate better inference making, monitoring, and integration of information across texts (Kieffer & Lesaux, 2012).

2.6 The Language and Literacy Demands of Science

As students progress through the upper primary and intermediate years, the texts they encounter grow steadily more complex. This is especially evident in science. Scientific writing presents distinctive linguistic challenges that extend beyond the strategies students use for everyday reading. These texts compress multiple ideas into single passages, creating conceptual density that requires sustained attention (Fang, 2006). They also employ specialised vocabulary with limited overlap to spoken language, which makes it difficult for learners to rely on everyday knowledge to construct meaning (Snow, 2010). In addition, science texts frequently use extended clause structures that demand close tracking of grammatical relationships, and the discourse style itself differs markedly from the narrative and conversational texts that dominate earlier schooling (Wellington & Osborne, 2001).

One important aspect of these linguistic demands is vocabulary. Beck et al. (2013) proposed a tiered vocabulary model that helps educators prioritise words for instruction by distinguishing between three levels of frequency and utility. Tier 1 words are everyday, high-frequency terms typically learned through oral language; Tier 2 words are general academic terms that occur across subject areas; and Tier 3 words are domain-specific and appear primarily in technical or content-area texts. Scientific texts frequently contain both Tier 2 and Tier 3 vocabulary, with additional complexity arising when meanings shift depending on disciplinary context. For example, *factor* refers to a variable in science but a component in multiplication in mathematics, creating semantic ambiguity that can confuse learners (Ford-Connors & Paratore, 2015). Scientific terminology is also often multimorphemic and built from Greek and Latin bases and affixes, which contributes to both its conceptual precision and its opacity for novice readers (Nagy & Townsend, 2012; Snow, 2010).

Beyond vocabulary, scientific texts are often syntactically dense and include structures that are uncommon in everyday speech. One prominent example is nominalisation, the process of converting verbs or adjectives into nouns. Such transformations increase abstraction and compress

complex processes into compact noun phrases, which raises the information load for readers (Halliday & Martin, 1993). While nominalisation enables scientists to condense and formalise ideas efficiently (Fang, 2006), it can obscure meaning for students who have not yet mastered the underlying grammatical shift (Snow, 2010). As Wellington and Osborne (2001) argue, “the major barrier to students learning science is not the difficulty of the ideas but the difficulty of the language” (p. 1). This highlights the need for explicit support that addresses the linguistic features of scientific discourse alongside its conceptual content.

Reading ability is one of the strongest predictors of success in science. The linguistic complexity of science texts places heavy demands on students, and research shows these demands directly influence achievement. In a study of US high school students, Cromley and Azevedo (2007) used structural equation modelling to demonstrate that reading comprehension shaped science performance both directly and indirectly through background knowledge and self-regulation. Evidence from younger learners reinforces this conclusion and highlights the challenges that struggling readers face. O’Reilly and McNamara (2007) found that intermediate and high school students with strong comprehension skills could compensate for gaps in prior knowledge by using linguistic and contextual cues, whereas weaker readers struggled to decode dense passages and interpret discipline-specific vocabulary. Best et al. (2008) similarly reported that adolescents with lower reading skills found expository science texts particularly challenging because these texts require building cohesion across sentences and integrating background knowledge. International data add further weight. Using Programme for International Student Assessment (PISA) data, Cromley (2009) showed that reading ability consistently predicted science performance across countries, with the effect strongest in high-literacy contexts where textual demands were greatest. Collectively, these findings demonstrate that strong reading comprehension supports science achievement, while weak reading skills create barriers to understanding content.

Theoretical perspectives reinforce this view of science as both a linguistic and conceptual enterprise. Norris and Phillips (2003) argued that reading is not merely a support for science but a constitutive element of it. They distinguished between fundamental literacy, the general ability to read and write, and derived literacy, the specialised practices required to engage with science texts. Glynn and Muth (1994) similarly emphasised that reading and writing are primary tools for constructing and deepening scientific understanding. Students therefore need to learn how to navigate the discipline-specific register of science. This includes decoding the academic Tier 2 language that supports reasoning and explanation, the technical Tier 3 terms that label and define scientific concepts, and the dense noun phrases and abstract nominalisations that characterise scientific discourse. Supporting students to master these linguistic conventions is essential for accessing scientific content and participating in disciplinary practices.

2.7 Cognitive Load Theory and the Linguistic Demands of Science

Cognitive Load Theory (CLT) provides a useful framework for understanding why science texts present persistent challenges for many learners (Sweller et al., 2011). CLT proposes that learning is constrained by the limited capacity of working memory, which must process new information during complex tasks (Paas et al., 2004; Sweller et al., 2019). Science reading places particularly heavy demands on this system because students must simultaneously coordinate conceptual understanding, linguistic processing, and navigation of specialised text features such as diagrams, dense noun phrases, and technical terminology (Fang, 2006; Snow, 2010). These demands mean that the cognitive effort required to comprehend a science text is often substantially higher than that required for more familiar narrative or everyday informational genres (DeLeeuw & Mayer, 2008).

A central concept in CLT is the distinction between intrinsic, extraneous, and germane load (Paas et al., 2004; Sweller et al., 2011). Intrinsic load reflects the inherent complexity of the material being learned (Paas et al., 2004; Sweller et al., 2011). In science, abstract concepts, long

noun phrases, and multimorphemic technical terms all contribute to this complexity, making texts more cognitively demanding from the outset (Fang, 2006). Extraneous load arises when information is presented inefficiently, such as when diagrams are separated from explanatory text or sentences contain unnecessarily dense syntax (Chandler & Sweller, 1991; Sweller et al., 2011). These design issues increase processing demands and can quickly overload working memory (Chandler & Sweller, 1991; Mikk, 2008). Germane load, by contrast, refers to productive mental effort invested in forming stable knowledge structures (Paas et al., 2004; Sweller et al., 2011). Instruction that encourages students to recognise linguistic patterns, reorganise information, or explain their reasoning strengthens the formation of these schemas (Paas et al., 2004).

The combined linguistic and conceptual demands of science texts create substantial cognitive challenges for learners, making targeted support essential for successful comprehension (Fang, 2006). Research on science text design indicates that small changes, such as clarifying key terms or adding appropriate signalling, can reduce processing demands and support comprehension for many learners (Strohmaier et al., 2023). Reducing extraneous load preserves working memory for meaning-making, allowing students to focus on understanding conceptual relationships rather than managing avoidable linguistic complexity (Paas et al., 2004; Sweller et al., 2011). Over time, this additional cognitive space supports the development of more efficient schemas for interpreting scientific language and ideas (Sweller et al., 2019).

Insights from CLT and reading research demonstrate that equitable science literacy depends on instructional design that intentionally manages cognitive load so that all learners can access complex disciplinary language (Paas et al., 2004; Sweller et al., 2019). Without explicit attention to cognitive load, the linguistic and conceptual features of science texts disproportionately burden learners with limited background knowledge or underdeveloped literacy skills (Hackemann et al., 2022). CLT therefore underscores that supporting students to read and learn from science texts is not simply a matter of simplifying content (Sweller et al., 2011). Rather, it involves carefully

managing the cognitive demands of disciplinary language so that all learners can engage meaningfully with scientific ideas, build robust schemas, and develop increasing independence as readers of complex academic text (Sweller et al., 2019).

2.8 The Aotearoa New Zealand Context

2.8.1 Aotearoa New Zealand's Achievement in International Assessments

Aotearoa New Zealand's performance in international studies details both areas of strength and significant challenges. The Programme for International Student Assessment (PISA) measures reading, mathematics, and science literacy among students aged 15 years 3 months to 16 years 2 months (OECD, 2023a). PISA reports proficiency in levels, with Level 2 representing the minimum baseline required for full participation in education and society and Levels 5 and 6 reflecting advanced reasoning and complex problem-solving skills (OECD, 2023b).

Recent PISA 2022 results present a mixed picture for Aotearoa New Zealand. A higher proportion of Aotearoa New Zealand students reached at least Level 2 in reading (79 percent) and science (80 percent) than the OECD averages of 74 percent and 76 percent (OECD, 2023b). Aotearoa New Zealand also surpassed the OECD average in high performance, with 13 percent of students achieving Levels 5 or 6 in reading and 12 percent in science. Despite these strengths, long-term trends are concerning. Mean science performance has declined over the past decade, and reading achievement remains below early-2000s levels (OECD, 2023a, 2023b). Aotearoa New Zealand compares favourably with some English-speaking countries but lags behind higher-performing jurisdictions such as Canada and Ireland.

These trends create a dual challenge. The system must continue to support high-performing students while also addressing persistent disparities for Māori, Pacific, and low socioeconomic learners. Scientific understanding depends heavily on interpreting multimorphemic terminology, specialised vocabulary, and dense text structures, all of which place substantial linguistic demands

on learners (Fang & Schleppegrell, 2010; Snow, 2010; Wellington & Osborne, 2001).

Strengthening students' capacity to navigate this language, including its morphological components, is central to improving both science participation and achievement (Fang & Schleppegrell, 2010).

2.8.2 How Science Is Taught in Aotearoa New Zealand: Curriculum Intent and Classroom Realities

The Aotearoa New Zealand Curriculum positions the Nature of Science (NOS) as the unifying strand of school science. Through NOS, students are expected to learn what science is, how scientific knowledge is produced, and how it is communicated. The four contextual strands of Living World, Planet Earth and Beyond, Physical World, and Material World provide contexts for developing NOS capabilities. These capabilities include investigating in science, understanding about science, communicating in science, and participating and contributing across content areas (Hipkins, 2007; Ministry of Education [MoE], 2007). The curriculum therefore prioritises inquiry, reasoning, and the clear communication of scientific ideas.

However, this vision has not been realised consistently. National monitoring shows a steep decline in science achievement from primary to intermediate. While 94 percent of Year 4 students met curriculum expectations in science, only around 20 percent of Year 8 students did so (MoE, 2018). Notably, principals reported that science was timetabled more often at Year 8 than at Year 4, which indicates that time allocation alone does not explain the decline. Instead, the evidence points to issues relating to pedagogy, teacher content knowledge, teachers' knowledge of language structure, and curriculum enactment (Education Review Office [ERO], 2021).

The NOS strand requires students to communicate scientific ideas, justify claims with evidence, and interpret complex scientific texts. These tasks all depend on understanding specialised vocabulary and the morphological structure of scientific terminology (Hipkins, 2007; MoE, 2007). Yet many teachers report limited preparation in linguistic knowledge, and this can reduce confidence to teach word structure effectively (Mahar & Richdale, 2008). These issues raise

important questions about the extent to which teacher preparation and professional learning support the curriculum's NOS-aligned intentions, especially for learners already experiencing inequitable outcomes.

2.8.3 Increasing Linguistic and Cultural Diversity

Curriculum design and time allocation are important, but equity in science learning also depends on how effectively teachers respond to the linguistic and cultural diversity present in contemporary classrooms. Persistent achievement gaps, especially for Māori, Pacific, and multilingual learners, suggest that the specialised language demands of science intersect with broader social and cultural factors that shape access to learning. Building on the patterns outlined in Section 2.8.1, national and international data show that Māori, Pacific, and low socio-economic learners are disproportionately represented among students achieving one to two years below curriculum expectations in literacy by Year 8 (ERO, 2021; OECD, 2023c). When students are expected to master increasingly complex concepts through unfamiliar academic language, those from diverse language backgrounds may face additional barriers unless teachers provide explicit support.

Aotearoa New Zealand classrooms are becoming markedly more diverse, both linguistically and culturally. Ministry of Education data show steady growth in the number of students who speak a language other than English at home, including te reo Māori, Pacific languages, and the languages of recent migrant and refugee communities (MoE, 2020a). For Māori learners, the connection between language, culture, and identity is fundamental to educational success, a principle explicitly embedded in *Ka Hikitia - Ka Hāpaitia: The Māori Education Strategy* (MoE, 2020b). Likewise, the Education Review Office's Pacific strategy highlights that Pacific learners thrive when their cultural and linguistic identities are affirmed and embedded in everyday teaching practice (ERO, 2019). These policies emphasise the importance of recognising students' cultural and linguistic backgrounds as an educational strength rather than a deficit.

At the same time, these demographic strengths present significant equity challenges. As noted, Māori, Pacific, and low socio-economic learners are more likely to experience delayed progress in literacy and are over-represented among those performing below baseline proficiency (ERO, 2021; OECD, 2023c). This is particularly concerning because the language demands of schooling, including science, intensify as students transition from upper primary to early secondary years. Science relies on specialised vocabulary, abstract reasoning, and complex text structures. Without explicit instructional attention to these language features, discipline-specific literacy can become a gatekeeper, limiting participation and achievement for students already underserved by the system (ERO, 2021).

A central challenge lies in the linguistic gap students must bridge between the everyday language used at home and the highly specialised academic language required in school subjects. Cummins (2000) conceptualises this difference through his distinction between basic interpersonal communicative skills (BICS) and cognitive academic language proficiency (CALP). For bilingual and multilingual learners, this transition is even more demanding. They must not only navigate two or more languages but also acquire the precise, abstract language of scientific explanation. Without deliberate scaffolding, this double shift can heighten barriers to comprehension and discourage deeper engagement with science learning.

A growing body of research and evaluation evidence underscores the importance of language-rich pedagogy in science classrooms. The Education Review Office (2021) reports that general literacy support, while helpful, is insufficient on its own. Students require targeted instruction in the academic language of science to fully access disciplinary learning. Snow (2010) similarly argues that participation in subject learning depends on explicit scaffolding of specialised vocabulary and discourse. Empirical studies show that systematic instruction in academic vocabulary (Fang, 2006), morphological analysis (Goodwin & Ahn, 2010), and the discourse practices of science (Nagy & Townsend, 2012) provides learners with essential tools for

understanding and communicating complex concepts. These approaches not only reduce inequities but also position linguistic diversity as a resource for learning, affirming students' cultural and language identities as integral to success (ERO, 2019; MoE, 2020b).

These contextual factors highlight the importance of instructional practices, such as morphology-based approaches, that make the specialised language of science accessible for diverse learners. In doing so, they connect the national achievement patterns and policy aspirations of Aotearoa New Zealand with the focus of the present study on intermediate teachers' understandings of morphology within science instruction.

2.9 Instructional Approaches to Morphology

Given the linguistic and cognitive demands outlined in the previous sections, instructional approaches to morphology must be explicit, systematic, and aligned with CLT principles. A substantial body of research shows that explicit morphological instruction improves vocabulary knowledge, decoding of complex words, spelling, and reading comprehension (Goodwin & Ahn, 2013). Goodwin and Ahn's (2013) meta-analysis of 30 studies reported moderate positive effects across these domains, with the strongest outcomes for English language learners and students with limited linguistic knowledge. Reed's (2008) synthesis similarly concluded that morphological instruction makes a unique contribution to comprehension beyond phonological and vocabulary instruction. These findings support the view that morphology is not an enrichment activity but an essential component of literacy instruction, particularly in the intermediate years, when students encounter increasingly dense and morphologically complex academic vocabulary (Nagy et al., 2006; Nagy & Townsend, 2012).

Effective morphological instruction reflects core features of explicit teaching (Archer & Hughes, 2011). It is systematic and cumulative, with teachers modelling how morphemes contribute to meaning, guiding students through supported practice, and providing opportunities for

application across varied contexts (Archer & Hughes, 2011; Moats, 2020). Making morphemes visible by breaking apart complex words, demonstrating how components contribute to meaning, and modelling morphological reasoning helps students recognise patterns that they would be unlikely to infer through incidental exposure alone (Bowers & Kirby, 2010). Instruction is most productive when it begins with highly transparent and frequent morphemes such as un-, re-, -ed, and -er, which have predictable form meaning relationships and reduce cognitive demand during early learning (Carlisle & Stone, 2005). Developmental evidence indicates that students typically acquire inflectional morphology before derivational morphology, reinforcing the importance of sequencing instruction to build on students' existing linguistic knowledge (Carlisle & Stone, 2005).

Explicit morphological instruction also functions as an equity-promoting practice (Goodwin & Ahn, 2013; Kieffer & Lesaux, 2012). By providing multiple pathways into word meaning, including semantic, syntactic, and orthographic cues, it supports learners who may have limited oral language experience or reduced background knowledge (Goodwin & Ahn, 2013; Kieffer & Lesaux, 2012). Evidence consistently shows that students with the greatest linguistic needs, such as English language learners and struggling readers, benefit disproportionately from explicit morphological teaching (Goodwin & Ahn, 2013; Kieffer & Lesaux, 2012). Meta-analytic and longitudinal studies indicate that these learners often make larger gains in vocabulary knowledge and reading comprehension than their more proficient peers when instruction targets morpheme analysis and generative word learning strategies (Goodwin & Ahn, 2013; Kieffer & Lesaux, 2012). By equipping all students with reliable tools for analysing unfamiliar words, explicit morphological instruction reduces disparities in access to academic texts and contributes to more equitable literacy outcomes (Goodwin & Ahn, 2013; Kieffer & Lesaux, 2012).

Morphological instruction also aligns closely with the principles of Cognitive Load Theory (CLT) (Goodwin & Ahn, 2013; Sweller et al., 2019). CLT proposes that learning is constrained by the limited capacity of working memory and emphasises the importance of reducing unnecessary

processing demands so learners can focus on constructing meaning (Paas et al., 2004; Sweller et al., 2019). Morphological analysis, defined as the application of morphological awareness and morphological knowledge, enables students to segment multimorphemic scientific terms into meaningful components (Apel, 2014; Bowers & Kirby, 2010; Carlisle, 2000; Nagy & Anderson, 1984). When learners recognise even one familiar morpheme within an unfamiliar word, they can use partial information to infer meaning rather than processing the word as an entirely novel sequence (Carlisle, 2000; Nagy & Anderson, 1984). This process reduces intrinsic cognitive load by decreasing the number of unfamiliar elements that working memory must manage.

Repeated work with common morphemes across scientific terms contributes to the development of schemas that help students interpret new vocabulary more efficiently (Bowers & Kirby, 2010; Nagy et al., 2006; Sweller et al., 2019). As schemas become more stable, learners can integrate new terms more readily and apply morphological strategies flexibly, which strengthens germane cognitive load, the productive mental effort devoted to schema construction (Paas et al., 2004; Sweller et al., 2019). This shift supports not only word-level processing but also the broader reasoning required to comprehend scientific texts, which frequently combine morphological complexity with dense conceptual information (Fang, 2006; Snow, 2010).

Morphological instruction is most effective when embedded within authentic scientific contexts rather than delivered as a separate word-study routine (Bowers & Kirby, 2010; Nagy et al., 2006). Scientific vocabulary is well suited to this approach because many terms are multimorphemic, belong to large morphological families, and encode conceptual relationships central to scientific understanding (Nagy & Townsend, 2012). Teaching students to analyse these structures fosters generative learning (Bowers & Kirby, 2010; Nagy et al., 2006). Recognising micro as “small,” for example, allows students to connect microorganism, microscope, and microhabitat, strengthening both vocabulary knowledge and conceptual understanding.

Embedding morphological reasoning in inquiry activities, informational text reading, and explicit science vocabulary instruction allows students to apply word-analysis strategies while engaging directly with disciplinary content (Bowers & Kirby, 2010; Nagy et al., 2006). This integration aligns with disciplinary literacy frameworks that emphasise the need for discipline-specific linguistic practices to construct and communicate knowledge (Moje, 2008; Shanahan & Shanahan, 2012). When morphology is embedded in this way, it becomes a meaningful tool for navigating and reasoning with scientific ideas rather than an isolated literacy task (Nagy & Townsend, 2012; Pearson et al., 2010). Such integration ensures that learners have the linguistic resources needed to access scientific concepts, make connections across related terms, and engage with science texts with increasing independence (Nagy & Townsend, 2012; Wellington & Osborne, 2001).

2.10 Summary and Research Gap

Across this review, three strands of evidence converge to highlight why morphology is a critical yet under-examined component of science literacy in Aotearoa New Zealand. First, reading theories show that as students progress through the upper primary and intermediate years, successful comprehension depends increasingly on efficient word recognition, robust vocabulary knowledge, and the ability to make meaning from complex academic language. Morphology sits at the intersection of these processes. It links word recognition to language comprehension by enabling students to recognise meaningful units within words, infer new vocabulary, and build the flexible lexical networks required for higher-level reasoning.

Second, the linguistic demands of science amplify the importance of morphology. Scientific texts, characterised by multimorphemic terminology, dense nominal groups, and abstract conceptual relations, require learners to draw on more than surface-level decoding or generic comprehension strategies. Morphology provides a generative tool for handling these demands by reducing the novelty of unfamiliar terms, supporting navigation of technical syntax, and helping students connect

related scientific concepts through shared word structures. In this sense, morphology is not an optional extension to literacy instruction. It is a disciplinary necessity for accessing science content.

Third, Cognitive Load Theory underscores why many learners struggle with scientific language. Without explicit strategies that reduce unnecessary processing demands and build stored knowledge structures, the intrinsic and extraneous load of science texts can exceed working memory capacity, particularly for students who enter intermediate schooling with limited vocabulary knowledge or weaker literacy foundations. Morphological instruction directly addresses this problem by helping students break technical words into meaningful components, which lowers cognitive load and supports schema construction over time.

Despite these converging insights, little is known about how Aotearoa New Zealand teachers understand or use morphology within science instruction. International research demonstrates strong benefits for vocabulary, comprehension, and equity, yet classroom enactment remains inconsistent, and Aotearoa New Zealand based evidence, particularly at Years 7 and 8, is sparse. Persistent disparities for Māori, Pacific, multilingual, and low socioeconomic learners further highlight the need for instructional approaches that make specialised scientific language accessible, culturally responsive, and sustainable in everyday practice.

What remains unclear is how intermediate teachers conceptualise morphology, whether they view it as relevant to science, how it is currently taught, and what conditions would be required for feasible, CLT-aligned implementation in real classroom settings. This gap limits the development of practical, scalable approaches that could support more equitable access to scientific texts and concepts.

The present study addresses this gap by investigating teachers' understandings, current practices, and perceived needs regarding morphology-based instruction in science.

2.10.1 Research Aim and Questions

Research Aim

The purpose of this qualitative study is to explore how Year 7 and 8 teachers in Aotearoa New Zealand understand and enact morphology-based approaches to support science vocabulary and comprehension, and to identify the conditions and instructional design principles required to implement such approaches in a feasible, sustainable, and CLT-aligned way.

Research Questions

1. How do Year 7 and 8 teachers conceptualise morphology and its role in science literacy?
2. In what ways do teachers currently integrate morphology-based instruction in science?
3. What conditions enable or constrain the use of morphology-based instruction in science?
4. What instructional design principles and supports do teachers identify as necessary for developing and implementing a morphology-based programme that is feasible, sustainable, and aligned with Cognitive Load Theory?

Chapter 3. Methodology

This chapter outlines the methodological approach used to investigate how Year 7 and 8 teachers in Aotearoa New Zealand understand and use morphology-based instruction to support science vocabulary and comprehension. Grounded in an interpretivist–constructivist paradigm, the study sought to explore teachers’ perspectives, knowledge, and classroom practices through rich, context-dependent inquiry. This chapter describes the initial and revised research designs, participant selection, data collection procedures, analytic approach, and ethical considerations that informed the development of credible and meaningful findings.

3.1 Initial Research Design and Ethical Process

The original intention of this study was to investigate the potential of explicit morphological instruction to enhance student outcomes in literacy and science. The proposed design involved a small-group teaching programme for Year 8 students who were underachieving in both areas, with the aim of examining whether explicit instruction in morphological strategies could support students in recognising, decoding, and understanding science-specific vocabulary and concepts. A secondary focus of the study was to explore whether participation in this programme influenced students’ self-perceptions as learners, particularly in relation to science learning, where language demands often constrain students’ ability to demonstrate conceptual understanding.

To address these aims, the initial study was designed as a mixed-methods project incorporating both quantitative and qualitative data sources. Quantitative data were to be collected through pre- and post-assessments measuring word recognition, vocabulary knowledge, and comprehension of key scientific ideas. These measures were intentionally selected to capture broader learning effects across literacy and science, rather than isolated gains in morphological knowledge alone. Qualitative data, including structured classroom observations and semi-structured interviews with students and caregivers, were intended to provide insight into learner engagement, the practical application of morphological strategies, and any observed shifts in attitudes toward

literacy and science tasks. Together, these complementary data sources were expected to offer a richer understanding of how morphology-based instruction could influence both academic performance and learner confidence.

Given the involvement of minors and the collection of academic and interview data, ethical considerations were central to the research design. Full ethical approval was sought from the Massey University Human Ethics Committee. The application included a comprehensive research proposal, draft interview protocols, and detailed information and consent forms for parents, caregivers, and school stakeholders, ensuring alignment with university ethical standards and requirements for research involving children. Ethical approval for the original study was granted on 11 December 2024 (OM3 24/37).

Despite this approval, the intended research site subsequently declined to participate, making it impossible to implement the planned student-focused intervention. As a result, the study was restructured to remove direct student involvement and instead focus on teachers' perspectives. While this represented a methodological shift, the revised design retained the central purpose of the research, namely to explore how morphological instruction could support science vocabulary development and reading comprehension at the intermediate level. The emphasis shifted from evaluating the impact of instructional delivery on student outcomes to investigating teachers' thinking, existing classroom practices, and the systemic and practical conditions required to design a morphology-based programme that could be feasible, effective, and scalable across Year 7 and 8 classrooms.

The following section outlines the methodology adopted for this revised study, including participant selection, the interview process, data analysis procedures, and the strategies used to ensure methodological rigour and ongoing ethical integrity.

3.2 Research Approach

A qualitative research approach was selected because it enables the collection of rich, in-depth, and context-specific insights into teachers' perspectives, instructional practices, and professional experiences (Merriam & Tisdell, 2016; Patton, 2015). Unlike quantitative approaches, which typically emphasise measuring variables, testing hypotheses, and identifying causal relationships across large populations (Creswell, 2014), qualitative research focuses on exploring meaning and interpretation within participants' natural settings (Creswell & Poth, 2018). Its central aim is to provide nuanced accounts of teachers' lived experiences and the factors that shape their instructional decision making (Grossoehme, 2014).

In educational research, qualitative inquiry is particularly valuable for examining the situated and evolving nature of classroom practice. It illuminates how teachers construct realities, attribute significance to events, and make decisions within specific institutional constraints (Merriam & Tisdell, 2016). This approach also provides a holistic understanding of professional contexts by examining the interplay between people, practices, and environments (Tenny et al., 2022). Such insights make it possible to identify the reasoning behind educators' choices, the barriers they encounter, and the opportunities for improving practice. In this study, qualitative methods were instrumental in generating teacher perspectives to guide the design of a morphology-based science vocabulary intervention that is both feasible and responsive to the realities of classroom teaching.

3.2.1 Theoretical Framework

Establishing a clear theoretical framework provides the foundation for coherent qualitative inquiry. It offers a lens through which the research problem is viewed, questions are formed, and data are interpreted (Grant & Osanloo, 2015). This study is situated within an interpretivist–constructivist paradigm. Such a paradigm is particularly suited to exploring the complex and

context-bound nature of educational experiences. In this case, it frames how teachers understand and address the language demands of science instruction.

Interpretivism seeks to uncover the meanings individuals assign to their behaviours, experiences, and interactions, prioritising the subjective viewpoints of research participants. Constructivism, closely aligned with this perspective, emphasises that knowledge is not discovered but co-constructed through interaction between the researcher and participants (Creswell & Poth, 2018). Together, these paradigms reject positivist notions of an objective reality, favouring a participant-centred, flexible approach that acknowledges the influence of culture, context, and experience in shaping understanding (Schwandt, 2000).

Within this interpretivist–constructivist orientation, the researcher is understood as an active participant in the meaning-making process. Knowledge is not discovered but co-constructed through interaction with participants (Schwandt, 2000). Rather than aiming for prediction or broad generalisability, the goal is to produce nuanced, situated insights that reflect the complexity of lived experience (Merriam & Tisdell, 2016). To achieve this, the study draws on semi-structured interviews and thematic analysis. Both are methodological choices that sit comfortably within an interpretivist–constructivist tradition and support its central commitment to exploring meaning (Braun & Clarke, 2006; Braun & Clarke, 2021).

3.3 Research Design

A qualitative exploratory design was adopted to explore teachers' perspectives on the language demands of science, with a particular focus on vocabulary and morphological awareness. Exploratory research is well suited to areas with limited prior study because it generates new insights, clarifies emerging concepts, and identifies promising directions for practice (Stebbins, 2001; Yin, 2014). In this study, such a design created space for a context-sensitive understanding of how teachers perceive and respond to the linguistic challenges of science texts, and how these

perceptions shape their instructional decision-making (Creswell & Poth, 2018). The aim was not to quantify outcomes or test hypotheses, but to build a rich, situated understanding of teacher perspectives that could inform the future design of a morphology-based programme to support science vocabulary and comprehension in intermediate classrooms.

Semi-structured interviews were used as the only method of data collection. This approach is widely used in qualitative research because it balances consistency across participants with the flexibility to pursue new and unexpected lines of inquiry (Guest et al., 2017). The interview guide (see Appendix 1) included questions on participants' approaches to teaching science vocabulary, their familiarity with morphological concepts, and their perceptions of student challenges and support strategies. The semi-structured format also allowed for probing and clarification. This gave participants space to share insights that were both meaningful and grounded in their everyday teaching contexts.

The qualitative design was intended to generate theoretically informed and contextually responsive recommendations that may be transferable to similar educational settings (Merriam & Tisdell, 2016). While qualitative findings are necessarily shaped by the specific context and the researcher's interpretive role, these factors were addressed through transparent documentation, reflexive practice, and a rigorous, systematic approach to thematic analysis (Nowell et al., 2017). These strategies enhance the credibility and trustworthiness of the findings. Ethical approval was granted by the Massey University Human Ethics Committee (Low Risk Notification: OM3 24/37), and all procedures adhered to the university's ethical standards.

3.4 The Role of the Researcher and Ethical Considerations

In qualitative research, the researcher is both a data collector and an interpreter, balancing ethical and methodological rigour with the relational work of fostering open, authentic dialogue with participants (Collins & Stockton, 2022). The researcher is never a neutral observer; presence,

positionality, and background shape how meaning is co-constructed. Recognising this, the present study maintained a reflexive stance. Deliberate attention was given to how assumptions, professional identity, and interpersonal dynamics influenced each stage of the research.

My position as a practising Year 8 teacher in Aotearoa New Zealand offered both advantages and risks. Shared professional experience created common ground with participants, helping to build trust and enabling nuanced understanding of classroom realities. However, this insider status also carried ethical and interpretive challenges. Participants might have perceived professional judgement, and I risked interpreting responses through my own teaching lens (Mercer, 2007). To mitigate these risks, I made my dual role explicit from the outset, emphasising voluntary participation and confidentiality.

Reflexivity was approached as an ongoing, integral part of the research process rather than a single checkpoint (Berger, 2015). Throughout the study, I maintained detailed field notes and analytic memos to document emerging assumptions, monitor potential biases, and record how my positionality shaped interpretation. Member checking of interview transcripts allowed participants to review and clarify their contributions, helping to ensure that their perspectives were accurately and fairly represented. Together, these strategies enhanced transparency, strengthened the credibility of the findings, and supported a research process that was both methodologically rigorous and ethically sensitive.

Ethical considerations were addressed at every stage of the study's design and implementation. Approval was obtained from the Massey University Human Ethics Committee (Low Risk Notification: OM3 24/37), and all procedures adhered to the university's ethical standards. Careful attention was given to the relational and interpretive nature of qualitative inquiry, particularly the need to minimise power imbalances and protect participants' professional dignity.

These measures aimed to create a respectful, safe space where teachers could speak openly about their practice without risk of judgement or professional harm.

The research was also informed by obligations under Te Tiriti o Waitangi, guided by the principles of partnership, protection, and participation (Hudson & Russell, 2009). These principles emphasise respectful collaboration with Māori, culturally safe engagement, and equitable opportunities to participate in and benefit from research. Although participants were not asked to disclose ethnicity, the study was also shaped by Māori research values such as manaakitanga (respectful care) and whanaungatanga (relationship building) drawn from broader kaupapa Māori scholarship (Bishop, 1996; Smith, 2012). These commitments aimed to uphold the dignity and agency of all teachers while acknowledging the systemic inequities Māori learners continue to face in education.

Ultimately, my dual role as teacher and researcher brought depth and complexity to the inquiry. Insider knowledge enabled deeper questioning and understanding of teachers' lived challenges, but this proximity required ongoing ethical sensitivity, transparency, and interpretive integrity. Through sustained reflexivity, culturally responsive practice, and adherence to ethical standards, the study aimed to produce findings that are both rich in insight and responsibly interpreted.

3.5 Participant Recruitment and Sample

Participants were selected using purposive sampling, a widely used approach in qualitative research where individuals are deliberately chosen for their relevance to the research question (Palinkas et al., 2015). In this study, classroom teachers with experience teaching literacy and/or science at the intermediate level were identified as having the expertise needed to provide informed insights into vocabulary instruction and morphological awareness in science.

Recruitment occurred over a four-month period (April–July, 2025) and involved several strategies to reach appropriate participants. Initial recruitment was conducted through the researcher’s existing professional networks, enabling efficient access to teachers who met the inclusion criteria. This approach resulted in the first three interviews and helped foster trust and openness during conversations. After completing three interviews, efforts were made to broaden the participant pool beyond the researcher’s immediate professional circle. Approaches were then made to other schools in the South Island of Aotearoa New Zealand. One school responded, leading to the recruitment of a fourth participant via initial email contact. This teacher met the same purposive sampling criteria but brought an independent perspective beyond the researcher’s established network. A university advertisement was also used to invite further participation; however, no additional responses were received.

Qualitative studies often rely on small, focused sample sizes to enable in-depth exploration of participant experiences, beliefs, and practices (Creswell & Poth, 2018). In this study, four classroom teachers participated in semi-structured interviews. This modest sample was intentional and well suited to the exploratory aims of the research. It enabled the researcher to engage closely with each participant’s responses, probe for deeper meaning, and follow up emerging lines of inquiry (Merriam & Tisdell, 2016). A smaller sample also allowed time for detailed transcription, careful coding, and iterative analysis, practices consistent with the qualitative emphasis on depth rather than breadth (Merriam & Tisdell, 2016).

Each participant brought distinct classroom experiences and instructional approaches, contributing to a nuanced picture of how teachers perceive the language demands of science and the role of morphology in supporting student learning. The focused sample ensured that each interview could be analysed thoroughly and meaningfully, strengthening the study’s credibility and insight (Nowell et al., 2017). Participant details are summarised in Table 1. Fuller narratives are provided at the start of the Findings chapter.

Table 1*Participant Background and Teaching Context*

Participant	Role	Years Teaching	Initial Training	Current Teaching Context	Science Levels Taught
Sarah	Year 7 homeroom teacher	4	Science	Year 7 homeroom (includes science and literacy)	Intermediate
Moana	Homeroom teacher	12	Primary education	Intermediate homeroom (includes science and literacy)	Intermediate, Secondary
Anita	Science specialist (Year 7–8)	8	Primary education (mathematics and physical education)	Year 7–8 science	Intermediate
Rachel	Science specialist, Head of Department	25	Secondary science specialist	Year 7–13 Head of Department for Science	Intermediate, Secondary

Note. Participant names are pseudonyms.

This approach reflects the guidance of Palinkas et al. (2015), who emphasise purposive sampling in applied educational settings where information-rich cases can be difficult to access. Qualitative studies typically rely on small, focused sample sizes to allow in-depth exploration of participant experiences, beliefs, and practices (Creswell & Poth, 2018). In this study, the final sample comprised four classroom teachers who participated in semi-structured interviews. This

modest number was intentional and well suited to the exploratory aims of the research. It enabled close engagement with each participant's responses, probing for deeper meaning and allowing the researcher to follow emerging lines of inquiry (Merriam & Tisdell, 2016). A smaller sample also allowed time for detailed transcription, careful coding, and iterative analysis, which are consistent with qualitative research's emphasis on depth over breadth (Merriam & Tisdell, 2016). Each teacher contributed distinct classroom experiences and instructional approaches, creating a nuanced picture of how educators perceive the language demands of science and the role of morphology in supporting student learning. These features strengthen the study's credibility and insight (Nowell et al., 2017).

3.6 Data Collection

3.6.1 Semi-Structured Interviews

To maximise accessibility and encourage participation, interviews were offered in both face-to-face and online formats. Two participants opted for in-person interviews, while one preferred Zoom. Providing this choice reduced barriers to participation and allowed teachers to engage in the setting that felt most comfortable to them. Offering multiple modes also reflected an ethical commitment to valuing participants' time and professional demands, acknowledging that teachers often juggle heavy workloads and competing responsibilities. As Galletta and Cross (2013) note, the strength of semi-structured interviews lies in their adaptability across communication modes, if conversational depth and integrity are maintained. In this study, both approaches supported the development of rapport and elicited rich responses. However, the face-to-face interviews provided an additional layer of insight by allowing the researcher to observe a broader range of nonverbal communication, such as posture shifts, subtle gestures, fidgeting, or how participants interacted with artefacts in their teaching environment. While some nonverbal cues, including facial expressions, pauses, gaze direction, and changes in tone, were still visible in the online interview,

the in person setting offered a more holistic view of participants' reactions and emotional states. This contributed to a deeper and more textured interpretation of their responses.

Interviews followed a protocol that was carefully designed to balance consistency with flexibility. The structure ensured that core areas of inquiry were addressed across participants, while still leaving space for unexpected insights to emerge (see Appendix 1 for the interview guide). Each session began with rapport building questions about the participant's teaching background and science instruction practices, which helped to establish trust and situate the discussion in the participant's lived context. Once this foundation was laid, the conversation moved into three central areas of inquiry. These included: (1) challenges in teaching science vocabulary, (2) perspectives on morphology, and (3) considerations for designing a morphology-based science programme. The sequence of these questions provided a logical flow, gradually moving from broader teaching practices to more specific reflections on morphology, ensuring participants could warm into the discussion before addressing potentially unfamiliar concepts.

All interviews were audio recorded with participant consent and lasted between 35 and 45 minutes. This length allowed sufficient time for participants to reflect deeply without imposing an unreasonable burden on their schedules. Open-ended questions were central to the design, giving participants freedom to respond in their own words. Follow-up prompts such as "Could you walk me through that?" were used to probe further, encouraging richer, more reflective accounts. This conversational style aimed to help participants feel heard and respected while also generating more detailed data.

The semi-structured format ultimately enabled the collection of rich, nuanced data that reflected teachers' lived experiences. Because the conversations were flexible yet purposeful, teachers could draw on their own classroom practice, professional knowledge, and reflections on student learning in ways that felt authentic and contextually grounded. These insights went beyond

surface-level descriptions of practice, instead offering layered accounts of how teachers perceive the language demands of science and the potential role of morphology. In turn, this depth of data directly informed the study's broader aim of designing a morphology programme that is not only theoretically robust but also responsive to the practical realities of intermediate science instruction.

3.6.2 Transcription of Interviews

Transcription was an essential step in transforming raw audio recordings into analysable data. To ensure accuracy and uphold ethical standards, participant validation was incorporated into this process. After each interview, recordings were carefully transcribed and returned to participants via email for optional review. This practice, commonly known as member checking, is widely recognised as a technique for enhancing the credibility of qualitative research (Birt et al., 2016). Member checking allows participants to confirm that transcripts reflect their intended meaning. It also gives them the opportunity to clarify points, add nuance, or request the removal of material they feel is inappropriate to include. This step is particularly significant in interpretivist research, where knowledge is not viewed as discovered but as co-constructed through the interaction of researcher and participant (Merriam & Tisdell, 2016). In this study, participants were informed that transcript review was entirely voluntary and that they had two weeks to suggest any additions, revisions, or deletions.

No changes were requested by any of the participants. While this outcome suggested that the transcripts had captured their accounts faithfully, the opportunity itself was equally important. It reinforced the collaborative nature of the research, emphasised respect for participant voice, and provided an additional safeguard against researcher misinterpretation. By embedding member checking in the transcription stage, the study strengthened both the credibility and the trustworthiness of its findings, ensuring that the analysis remained grounded in participants' perspectives.

3.7 Data Analysis

To analyse the qualitative data collected in this study, a reflexive thematic analysis approach was adopted. This method, as outlined by Braun and Clarke (2012), offers a flexible yet theoretically robust framework for identifying, analysing, and interpreting patterns of meaning within a dataset. Reflexive thematic analysis is built on the recognition that meaning is not simply discovered within data. Instead, it is co-constructed through the interplay of the participants' accounts, the researcher's interpretive lens, and the theoretical framework guiding the study.

Within this approach, codes are not treated as objective labels that emerge naturally from the data. Rather, they are understood as analytical tools, constructed and shaped through the researcher's insights, positionality, and engagement with the research context (Braun & Clarke, 2019). This perspective aligns closely with the interpretivist–constructivist paradigm underpinning the study. Because this paradigm views knowledge as socially and contextually constructed, it requires analysis that goes beyond surface-level repetition to engage with the deeper meanings embedded in participants' accounts.

In line with this stance, repetition alone was not considered sufficient for a theme to be deemed significant. Instead, themes were actively developed by drawing together three key elements:

1. The content and nuance of the data itself;
2. The conceptual and theoretical assumptions underpinning the study;
3. The researcher's analytical experience and interpretive judgement.

To assess the significance and relevance of emerging themes, the analysis began with a comprehensive reading of the full interview transcripts. Starting with the complete dataset ensured that patterns were interpreted within their broader conversational and contextual frames. Once familiarisation with the data was achieved, the focus narrowed to specific segments that captured

recurring ideas, tensions, or insights. From these, representative excerpts were selected to illustrate and support each theme. This step was not merely illustrative; it allowed for a more nuanced interpretation of participants' perspectives while preserving the integrity of their intended meanings. The progression from whole transcripts to focused excerpts ensured that interpretation remained anchored in context while enabling deeper analytical precision.

Each thematic category was then evaluated against three guiding criteria to determine its analytical weight and relevance. The first was the extent to which the data illuminated participants' underlying reasoning, beliefs, and instructional practices, providing insight into how teachers conceptualise and approach science vocabulary instruction. The second involved assessing alignment with the study's theoretical framework, particularly principles of reading development, the linguistic demands of science, morphology, and Cognitive Load Theory. The third considered the practical potential of the data to inform the design of a morphology-based intervention aimed at enhancing science vocabulary instruction. This layered and reflexive analytic process ensured that the resulting themes were grounded in participants' lived experiences and situated within broader educational and theoretical debates. In this way, thematic analysis functioned not only as a method for organising and coding data but also as a vehicle for generating insight, deepening understanding, and shaping practical recommendations for instructional design.

3.7.1 Phase 1: Familiarisation with the Data

The first step of analysis involved deep immersion in the dataset through repeated reading of transcripts and relistening to audio recordings. Each transcript was revisited multiple times, with attention to words, as well as tone, pauses, and other linguistic nuances. Notes were made in the margins, capturing initial observations, key ideas, and recurring concepts. This process was particularly important given the richness of the interviews, which covered instructional practices, language challenges, and curriculum constraints. Familiarisation provided a holistic grounding and ensured that subsequent phases were firmly anchored in participants' perspectives.

3.7.2 Phase 2: Generating Initial Codes

The next stage involved systematically coding the dataset, using a deliberate blend of deductive and inductive strategies. The deductive approach was guided by the study's theoretical framework, which focused attention on key constructs such as extraneous cognitive load, schema building, morphological awareness, and the linguistic demands of science. These concepts provided a set of analytical signposts, helping to identify where participants' experiences intersected with established theories of reading and instruction. At the same time, the process remained open to inductive insights. New ideas, unexpected connections, and participant-led interpretations were allowed to emerge naturally from the data without being constrained by pre-existing assumptions. This dual approach ensured that the coding remained both theoretically informed and responsive to what participants actually said.

Coding was completed manually to enable close and sustained engagement with the transcripts. Some codes were descriptive, capturing participants' words or phrases directly as they were spoken. Others were more interpretive, reflecting deeper analytical thinking about how the data related to broader conceptual ideas. At this stage, codes were not treated as final themes. Instead, they functioned as initial organising units, early building blocks that connected classroom realities to theoretical perspectives. These codes were then clustered into preliminary categories based on conceptual similarity. This process laid the groundwork for deeper interpretive analysis and the development of the core themes presented in the findings chapter.

3.7.3 Phase 3: Constructing Themes

Once the initial coding was complete, related codes were clustered into broader patterns. This marked a shift from descriptive labelling to interpretive analysis. The task involved examining how individual codes could be grouped into candidate themes that captured underlying meaning. For instance, the codes "dense science texts," "students struggle with long words," and "too much jargon" were brought together under a broader theme focused on challenges with scientific

language. This step required iterative reflection and was guided by the voices of participants and the study's theoretical framework. At this point, the analysis moved from asking *what* participants said to considering *why it mattered* in relation to the research questions.

3.7.4 Phase 4: Reviewing Themes

The review phase was recursive and involved testing the strength of themes at two levels. First, each theme was assessed internally to ensure that the coded data within it cohered meaningfully. Second, themes were examined across the entire dataset to confirm that they captured the breadth and depth of participant experiences. During this stage, themes were revised, merged, or separated to enhance clarity and ensure alignment with theoretical concerns. This refining process was critical for building an analytical structure that was coherent and robust before moving into final interpretation.

3.7.5 Phase 5: Defining and Naming Themes

With themes finalised, they were defined more precisely and named in ways that conveyed their central analytic insight. Early working titles, such as "Science and Literacy Integration," were reshaped into sentence style names like "Gaps in subject-specific vocabulary limit students' ability to express scientific understanding." This naming strategy made interpretation explicit and reader-friendly. Detailed descriptions were written for each theme, supported by representative quotes to illustrate the meaning. At this stage, analysis moved beyond organisation to theoretical interpretation, explicitly linking themes to broader educational issues and frameworks.

3.7.6 Phase 6: Producing the Report

The final phase of analysis focused on weaving the identified themes into a coherent narrative within the findings and discussion chapters. This stage provided the foundation for interpreting teachers' insights in relation to the study's aims. Each theme was carefully contextualised within relevant theoretical perspectives and supported by rich, illustrative quotations

from participants. These quotations ensured that teacher voices remained central to the interpretation rather than being overshadowed by theory. The analysis placed particular emphasis on frameworks most closely aligned with the study's focus. Concepts related to morphological knowledge, vocabulary development, and models of reading acquisition were foregrounded to situate the findings within wider debates about language and literacy in science education. Cognitive Load Theory was also included as a complementary perspective. It offered additional insight into how instructional design decisions intersect with language processing demands and, in doing so, helped to strengthen the conceptual framing of the findings.

This phase represented far more than a descriptive account of teacher perspectives. It marked the culmination of the interpretive process, where participants' insights were brought into dialogue with key theoretical ideas. Empirical evidence was linked to conceptual models of morphology and reading development, while also considering the cognitive conditions that shape classroom practice. Through this synthesis, the analysis moved beyond interpretation to translation. Teachers' experiences were transformed into practical design principles that can guide classroom instruction. In turn, these principles became actionable recommendations for a morphology-based science programme that is not only theoretically grounded but also feasible, sustainable, and responsive to real classroom contexts. The following chapter presents these themes in detail, showing how teachers' perspectives illuminate both the theoretical foundations and the practical pathways for implementing morphology-based science instruction.

Table 2*Phases of Reflexive Thematic Analysis and Their Application in This Study*

Phase	Name	Purpose	Key Actions Taken
1	Familiarisation	Immersion in dataset	Read and re-read transcripts; listened to audio; wrote margin notes and initial impressions.
2	Coding	Label data segments	Conducted manual line-by-line coding using inductive and deductive approaches.
3	Theme Development	Build patterns	Grouped related codes into broader categories reflecting recurring ideas.
4	Theme Review	Refine and validate themes	Checked coherence and distinctiveness across dataset; revisited data for rigour.
5	Defining and Naming Themes	Clarify analytic meaning	Defined each theme's central concept; named themes; selected quotations.
6	Producing the Report	Present findings in context	Integrated themes into chapters; linked analysis to frameworks and research questions.

Note. Phases adapted from Braun and Clarke's (2006, 2021) model of reflexive thematic analysis.

Chapter 4. Findings

This chapter presents the findings from semi-structured interviews with teachers working in Year 7 and 8 settings. The study aimed to explore how teachers understand and use morphology-based instruction to support students' science learning, and to identify the conditions and supports needed to make such instruction feasible, sustainable, and aligned with Cognitive Load Theory. Specifically, it sought to understand how teachers conceptualise morphology and its role in science literacy, how they currently integrate morphology-based practices, what factors enable or constrain their use, and what forms of support they view as necessary for effective programme design.

Using Braun and Clarke's (2006, 2012) reflexive thematic analysis, five overarching themes were developed from the data. Each theme is presented in the sections that follow, supported by illustrative participant quotations and interpretive commentary. These findings provide new insights into the language demands of science, the challenges teachers face in addressing them, and the potential of morphology-focused instruction to improve science literacy outcomes in the middle years of schooling.

4.1 Overview of Participants / Context

4.1.1 School Context

The participating schools were composite schools (Years 7–13) located in urban areas of the South Island of Aotearoa New Zealand. They included a mix of mainstream and special character institutions, reflecting the diversity of educational settings in which science teaching takes place at the upper primary and lower secondary levels. In these schools, intermediate (Years 7–8) and secondary (Years 9–13) year-levels are combined. As a result, many students remain in the same school from early adolescence through to their final years of secondary education. This continuity shapes teaching practice in distinctive ways. It influences curriculum progression, the degree of teacher specialisation, and how literacy and science learning develop across year-levels.

All participating schools were state-funded and followed the Aotearoa New Zealand Curriculum, with science taught as a core learning area. In most cases, science was delivered in specialist classrooms. However, some programmes also incorporated cross-curricular or homeroom-based approaches, particularly in the junior years. The inclusion of both mainstream and special character contexts offered varied perspectives on institutional priorities, resource availability, and approaches to language and literacy instruction. These differences in context provided valuable insight into how morphology-focused instruction might be implemented flexibly across a range of educational settings.

4.1.2 Participant Background and Context

Four teachers participated in this study, all of whom were responsible for delivering science to students in Years 7–8. All participants completed their initial teacher education in Aotearoa New Zealand and held recognised teaching qualifications. Three participants identified as New Zealand European/Pākehā (Sarah, Rachel, and Anita) and one identified as Māori (Moana). Although all had experience working with the same year-levels, they brought varied teaching backgrounds, roles, and professional experiences, offering a diverse range of perspectives on how morphology is understood and applied in science instruction.

- Sarah is an intermediate teacher with four years of classroom experience. Originally trained in science, she currently works in a Year 7 homeroom setting, where she teaches across multiple learning areas, including science and literacy. This dual focus has heightened her awareness of the language demands embedded in science instruction and prompted ongoing reflection on how literacy can be more explicitly integrated into her teaching practice.
- Moana has 12 years of teaching experience and a background in primary education. Since transitioning into intermediate teaching, she has taught science both within homeroom settings and as part of cross-curricular programmes that extend into the junior secondary years (Years 9–10). While she expressed strong confidence in curriculum delivery and

student engagement, she acknowledged having had little formal preparation in explicitly teaching the language of science.

- Anita has taught science for eight years. Initially trained as a primary teacher with a focus on mathematics and physical education, she now works as a specialist science teacher in a Year 7–8 context. Her classroom practice emphasises hands-on inquiry and discussion-based learning. At the same time, she described her approaches to literacy, particularly morphology, as still evolving.
- Rachel is the most experienced participant, with 25 years of teaching experience. She is a science specialist and Head of Department in a composite school, where her teaching spans Years 7–13. Her role includes delivering junior science programmes and senior subjects such as biology, chemistry, physics, and earth science. She contributed insights from both classroom and leadership perspectives, highlighting differences in instructional practice across year-levels and the structural factors that shape science teaching.

These participants offered overlapping yet distinct insights. Their experiences reflect both classroom realities and broader structural factors, shaped by role, responsibility, and professional journey. This diversity provided a rich foundation for the five themes developed in the findings chapters.

4.2 Theme One: Application gaps in scientific vocabulary limit students' expression.

All participants noted discipline-specific vocabulary as essential to success in science. They emphasised that understanding and accurately using scientific terms is not optional but a prerequisite for engaging with science texts, contributing to discussions, and demonstrating learning in assessments. However, students often struggled to apply this vocabulary effectively, even when they had a sound conceptual understanding gained through practical activities or oral explanations. This disconnect between understanding and expression emerged as a significant barrier to achievement. Participants described how students could explain scientific processes informally but

faltered when required to use the precise language of science, revealing a persistent gap between everyday communication and disciplinary expression.

Sarah described this gap, noting that surface-level fluency often concealed underlying conceptual confusion. Students who could read scientific terms accurately were frequently unable to define or use them appropriately when required to do so independently, especially in assessment settings. *“Even strong readers can get tripped up by scientific terms... I couldn’t get my head around why they could read it so well, but when it came to the assessment, the mistakes were what I would have thought were fairly obvious.”* Sarah further explained that students often defaulted to everyday language when asked to explain scientific phenomena: *“They can describe what is happening, you know, in everyday language. But not using the scientific terms.”* In some cases, Sarah identified how superficial fluency resulted in significant misunderstandings. This included confusion between terms that share the same root but differ in meaning due to their affixes. *“For example, the words compose and decompose. I thought it was pretty obvious what it was, yeah? Yet, I had a student use the wrong term in an assessment... it was the completely incorrect term.”* Such errors reveal that students’ grasp of scientific vocabulary is often fragile and easily misapplied, even when they appear confident, highlighting the importance of explicit teacher support to help students connect oral understanding with accurate academic expression.

Moana also described how students often struggle to translate their conceptual understanding into precise academic language, especially when vocabulary is unfamiliar or insufficiently explained. She recalled an incident with a high performing student who misunderstood the distinction between two key science terms. *“He got the whole concept about what an insulator was compared to a conductor around the wrong way... and when I questioned him about it, he didn’t know any differently.”* Although this student was typically confident in literacy, his error revealed how gaps in discipline-specific vocabulary can distort comprehension when terminology is not explicitly taught or reinforced. Moana reflected that such

misunderstandings often occur when teachers assume prior knowledge or overestimate students' exposure to technical terms. *"It probably was through me not doing enough repetition and just expecting them to know about insulation where that's probably not a word they'd necessarily come across."*

This example illustrates that general literacy proficiency does not automatically translate into mastery of disciplinary vocabulary. Rather, it highlights a common belief shared by several participants that vocabulary develops through exposure and repetition. However, Moana's own reflections suggest that she, too, recognised the limits of this approach. Her comment implies that repetition alone was insufficient. This indicates that students need more deliberate, structured opportunities to revisit, practise, and apply scientific language if they are to accurately connect conceptual understanding with the specialised terms used to represent it.

Anita echoed similar concerns, particularly in relation to English language learners (ESOL). She described how her classroom emphasised vocabulary visibility through strategies such as word walls, games, and visual cues. However, she noted that students still frequently misinterpreted scientific terms, leading to confusion in both written and oral explanations. One example was particularly illustrative. *"There was a kid the other day, they thought the whole time that transpiration was transportation... so when it came to doing something, they were like, 'Oh, it's not transportation.'"* Anita stressed that such confusion was not the result of a lack of effort or engagement, but rather reflected the inherent complexity and unfamiliarity of scientific vocabulary. Although her strategies increased the exposure and accessibility of key terms, she acknowledged that exposure alone was insufficient to ensure deep understanding. *"We've got vocab lists everywhere... but for our ESOL kids, that's a huge barrier."*

Anita's reflections demonstrate that tools like word walls and visual cues can make vocabulary more visible. However, they do not guarantee that learners will internalise or accurately

apply scientific terms. This shows the limits of incidental exposure and reinforces the need for explicit, scaffolded vocabulary instruction, which is a view that aligns closely with Moana's evolving realisation. Both teachers' experiences suggest that while exposure and repetition are necessary, they are not sufficient; deep, durable vocabulary learning requires intentional instruction that helps students bridge the gap between conceptual understanding and the disciplinary language that represents it.

Rachel emphasised that vocabulary gaps frequently undermined students' ability to demonstrate their understanding. As she explained, "*They don't have the vocabulary, they can't describe what they understand. And often they do understand it if you can break it down into a bit or something that might be a similar example in a different context.*" Like Moana and Anita, Rachel observed that students' conceptual grasp was often obscured by linguistic difficulties, with unfamiliar or complex terms acting as a barrier to accurate expression. This disconnect between knowledge and language suggests that difficulties in vocabulary do not necessarily reflect a lack of understanding, but rather a mismatch between what students *know* and their ability to *articulate* it in the disciplinary register of science.

Rachel extended this insight by describing the additional barriers created by the spelling and pronunciation demands of scientific terminology. She identified these as challenges that were particularly pronounced for students with dyslexia. Rachel explained that errors often occurred when students were copying notes or relying on voice to text software. "*Some of our dyslexic students will use it that way. I do find the spelling of some of those scientific terms quite tricky, like it doesn't pick it up that voice to text particularly accurately at times. And if kids are copying notes from the board, they often spell things incorrectly as well. So it is a barrier.*" Her comments point to a subtle but significant dynamic. When spelling errors or transcription inaccuracies occur, they can be misinterpreted as evidence of conceptual misunderstanding, even when the underlying knowledge is sound. In this way, orthographic accuracy becomes conflated with scientific

competence. This is a problematic assumption for neurodivergent learners whose difficulties lie not in conceptual reasoning but in the mechanical processes of encoding language.

The participants' perspectives reveal a consistent challenge. Even students who are fluent readers or demonstrate strong conceptual understanding falter when faced with the abstract and technical vocabulary of science. This difficulty was not limited to struggling learners. Rather, it appeared across the ability spectrum, creating a persistent gap between general reading proficiency and discipline-specific language mastery. Hands-on tasks, practical investigations, and oral explanations often revealed deep conceptual understanding. Yet translating that knowledge into precise scientific language remained a significant hurdle. Importantly, this challenge was shaped by more than student ability. The development of discipline-specific vocabulary was also influenced by teachers' beliefs, particularly their assumptions about prior knowledge, exposure, and the incidental nature of vocabulary growth. When teachers overestimated what students already knew, or assumed that repeated exposure would be enough, instruction often became less explicit and less sustained. This, in turn, reinforced the very gap it aimed to close, leaving many learners able to grasp scientific ideas but unable to express them in the language the discipline demands.

4.3. Theme 2: Science vocabulary instruction is informal, variable, and lacks system-wide consistency

While all participants recognised the importance of vocabulary instruction in science, their current approaches were largely informal, reactive, and shaped by individual teacher knowledge and confidence. There was no evidence of a consistent or explicitly structured system for teaching science-specific vocabulary across year-levels or departments. Instead, strategies tended to be implemented as needs arose rather than following a deliberate, planned progression. This ad hoc approach resulted in considerable variation, evident not only in how and when vocabulary was taught

Sarah reflected on how her own vocabulary instruction practices had evolved since taking on responsibility for teaching literacy. However, she acknowledged that instruction remained largely unstructured. Early in her teaching, vocabulary was rarely a focus. *“To be honest, I never used to prioritise it,”* she admitted. This lack of prioritisation may have stemmed from a limited understanding of how complex and conceptually demanding science specific language can be for students. As her awareness of this complexity grew, she began introducing small but meaningful changes to her practice. For example, she described pre-teaching key terms at the start of science units and using diagrams or analogies to help students connect new words to prior knowledge. *“Sometimes I’ll chunk the term [by breaking it into prefixes and suffixes] and try to get students to connect it to something they already know.”* However, these shifts were self-initiated rather than the result of coordinated departmental planning or targeted professional development. This suggests that improvements in vocabulary instruction were often dependent on individual teacher interest, motivation, and professional curiosity rather than systemic support. As a result, practices remained inconsistent, and the development of science vocabulary relied more on teacher autonomy than on a shared, research-informed framework guiding instruction across classes and year-levels.

Moana described a similar tension between intent and execution. Although she had begun incorporating elements of structured literacy through short vocabulary sessions adapted from the iDeaL framework, this was not yet a consistent feature of her science teaching. iDeaL is a New Zealand-developed programme that claims to be grounded in structured literacy principles and a strong emphasis on explicit teaching of phonology, morphology, and vocabulary in short, systematic sequences (Learning Matters, n.d.). *“I think that using a bit of the iDeaL vocab, lesson sequence... the wee 10-minute vocabulary lessons, I’ve been trying to use that in classes,”* she explained. When scientific terms arose during lessons, Moana sometimes paused to draw attention to suffixes or related forms. For example, she noted, *“One that we’ve been doing is conservation, and then talking about conservationists, things like that.”* While this approach aimed to extend

students' word knowledge, it also appeared to assume a level of prior familiarity with the base word. This sometimes increased the complexity of the task rather than reducing it. Breaking the word into more transparent parts (for example, *conserve* + *-ion*) could have provided a clearer pathway into meaning. Reflecting on her practice, Moana admitted, "... *I think there's definitely room for improvement.*"

Moana's comments reveal both a strong desire to embed vocabulary instruction more intentionally and a lack of clear guidance on how to do so effectively. Without formalised structures, shared pedagogical models, or sustained professional learning, vocabulary instruction continues to depend heavily on individual initiative and partial understandings of how to scaffold word knowledge. This reinforces the broader theme. Even when teachers recognise the need for explicit vocabulary instruction, implementation often remains inconsistent, fragmented, and shaped by personal interpretation rather than cohesive, system-wide practice.

Anita described the prominent visibility of vocabulary in her classroom. She explained that word lists were consistently displayed on slideshows and walls and that games such as Bingo were used to reinforce key terms. "*Every time we've got a lesson, teachers are encouraged to have a vocab list up... so that they can kind of access those words all the time,*" she explained. However, her description raises an important distinction. *Visibility* does not necessarily equate to *accessibility*. Students may be able to see the words throughout a lesson, but this does not guarantee that they can understand, retrieve, or apply them accurately in new contexts. Visibility may therefore serve as an initial scaffold for students. However, it is insufficient without deliberate instructional strategies that help students use and internalise the language.

Anita's use of the word "encouraged" rather than "expected" also pointed to the optional nature of these practices, suggesting that they depended on individual teacher initiative rather than a shared or mandated approach. She highlighted variation across colleagues, describing one teacher

who attempted to make vocabulary more interactive. *“I’ve got a new teacher, and she’s done something a little bit different... she’s written the words on a sheet and then folds it over, so students see the term first and then reveal the definition underneath, like you would if you were teaching it in your homeroom.”* This practice suggests an attempt to prompt active recall, but it still falls short of explicit vocabulary instruction. Students are being shown the term and definition in a hands-on manner, but they are not necessarily being taught how to deconstruct, analyse, or use the words in disciplinary contexts.

Unlike Moana, who recognised that exposure alone was insufficient for meaningful vocabulary learning, Anita appeared to place greater value on visibility as a tool for accessibility. Yet both perspectives ultimately described the same core issue. Without clear, system-wide expectations for explicit vocabulary instruction, approaches remained inconsistent. In this way, Anita’s classroom reflected the broader pattern seen across participants. Vocabulary was present and often visible, but teaching practices were informal, variable, and reliant on individual decisions rather than coordinated structures or shared pedagogical frameworks.

Rachel reinforced these concerns, demonstrating the inconsistency of vocabulary instruction across her department. *“I think it would be really different for every teacher. I’m not quite sure how everyone else does it. We’re quite a big department, so there’s 10 of us in this department, all teaching slightly differently, probably.”* She acknowledged that while she sometimes introduced prefixes and suffixes, this was rarely sustained. *“We talk about it once and it might be in their notes, but in terms of reiterating, that probably doesn’t happen very often, to be honest.”* Reflecting further on the limits of her own practice, she admitted: *“Breaking that word down at the start, but as I said, we’re not that good about going back to it sometimes. I’m not sure what else we do actually. That’s probably it.”*

Across all participants, vocabulary instruction during science lessons was present but inconsistent, shaped more by individual initiative than by any form of systemic planning or shared practice. Participants described a range of strategies, from pre-teaching and analogies to word games and occasional morphological analysis, yet none referred to a coordinated, cumulative approach. This variability created uneven experiences for students. Some received regular support while others only encountered vocabulary instruction sporadically. The findings suggest that teachers need more than just awareness of vocabulary's importance. They require sustained professional learning, shared frameworks, and practical tools that embed vocabulary teaching as a deliberate and iterative process across units, year-levels, and departments. Such structures would not only help ensure consistency but also support teachers to revisit and deepen vocabulary instruction over time, moving beyond one-off lessons toward a coherent, scaffolded approach that actively builds students' discipline-specific vocabulary knowledge.

4.4. Theme 3: Teachers show limited understanding of morphology and use it only incidentally

Participants demonstrated only a surface-level understanding of morphology, typically referring to it as the addition or removal of common prefixes and suffixes rather than recognising it as the broader study of word structure, meaning, and formation. Their comments revealed uncertainty about what morphology fully entails and how it could be deliberately integrated into science instruction. None described it as a routine, planned, or structured part of their teaching. Instead, morphological references appeared incidentally, often in passing, and usually within the context of a single science lesson. For example, teachers sometimes paused to highlight a familiar affix or recalled encountering morphology through literacy-focused initiatives such as spelling programmes. However, these experiences were usually framed around *spelling* or *decoding* morphemes rather than exploring how meaning is constructed through word parts. While most participants recognised that morphology *might* support vocabulary learning, their understanding of

what it entails and how it could be applied in science remained vague. Several admitted they did not feel confident using it beyond a basic word level discussion, and none demonstrated knowledge of how morphological instruction could be used systematically to build scientific language. As a result, morphology remained on teachers' radar only in a general or peripheral sense, with its potential for deepening students' understanding of complex science vocabulary largely untapped.

Sarah's reflections illustrated this pattern clearly. Although she had not received explicit training in morphology, she had begun to recognise its value through her involvement in literacy-focused initiatives. Occasionally, she applied morphological analysis to explain the meaning of challenging scientific terms. *"If we come across a word like photosynthesis I might break it up and explain photo means light and synthesis is putting together. But that's more of a one-off explanation than a structured part of my teaching."* This example shows how morphological instruction, when it did occur, was reactive and confined to single moments of clarification rather than embedded as part of an intentional vocabulary-building approach. Sarah noted that her limited knowledge had primarily come from the iDeaL spelling platform, which introduced basic affixes but focused mainly on *decoding* rather than *meaning*. This restricted lens shaped how she applied morphology in science. Reflecting on her confidence, she admitted, *"I wouldn't say I feel confident teaching it... I'd love to know more about how to use it to really unlock the meaning of those more challenging science words."* Her comments capture a broader trend across participants. While teachers recognised that morphology has significant potential, there was little clarity around how to use it as a deliberate instructional tool. In the absence of professional learning, shared resources, or examples of effective practice, its implementation remained limited, representing a missed opportunity to equip students with strategies for understanding and constructing scientific vocabulary.

Moana similarly described her use of morphology as limited but gradually increasing, particularly due to her school's recent emphasis on structured literacy. She noted, *"I'm starting to do it a lot more with all the work we've done around structured literacy, especially those suffixes*

and prefixes... we definitely do it when we're integrating science into our reading lessons." Her use of "we" refers to teaching staff more broadly, suggesting that the shift towards morphological attention may be part of a wider school-level literacy focus rather than an isolated individual practice. However, her example also reveals an underlying conceptual tension. Morphology is applied *when science is brought into reading*, but not necessarily *when reading is brought into science*. This implies that science is still largely conceptualised as a content area separate from literacy rather than as a discipline with its own language demands.

Although Moana's intention to integrate morphology had strengthened, she admitted that her confidence remained highly contingent on her own familiarity with the vocabulary:

That would be word-dependent for me... as long as I have a little bit of time to prepare myself... then I'm pretty happy to teach it. It's on-the-spot teaching for some of those words that I second guess myself.

This reliance on preparation time suggests that her ability to teach morphology was closely tied to her personal knowledge rather than supported by formal training or shared instructional approaches. In the absence of discipline-specific professional learning, she felt less able to deconstruct complex terms in a systematic and explicit way. This gap is particularly significant in science, where terminology often involves highly technical, Tier 3 vocabulary (Beck et al., 2002). As a result, morphology remained an incidental rather than embedded component of instruction, shaped by teacher confidence rather than by structured pedagogical knowledge.

Anita's comments further highlighted this limited understanding. She openly admitted that she had not encountered the term *morphology* before the interview. *"I've never used that terminology... I was like, what does that actually mean? But it makes so much sense."* While she could recall instances where she believed she was "breaking down" words, her examples revealed a misunderstanding of what morphology entails. For instance, she described using a coffee percolator

to explain *percolation*, an approach that, while conceptually useful, focuses on real-world analogy rather than on the morphological relationship between the base word *percolate* and its nominalising suffix *-ion*. This may reflect an intuitive sense of word relationships, rather than explicit knowledge of morphological structure or instructional application (see Bowers et al., 2010).

Similarly, Anita described breaking words into syllables or associating them with visual cues. These strategies may support phonological awareness or semantic connections but do not engage with morphemes as the smallest units of meaning. Reflecting on her practice, she concluded, *“I guess you kind of do it when you’re introducing stuff, but probably not as a structured kind of... that’s what it’s called.”* While she recognised the intuitive logic of analysing word parts once the concept was explained, her comments suggest she did not fully understand morphology as a linguistic construct. As a result, her current strategies, though potentially helpful for memory and comprehension, lacked the precision, transferability, and generative power that explicit morphological instruction offers. This demonstrates not only the shallow depth of participants knowledge but also the need for targeted professional development to help educators differentiate between related literacy strategies and genuine morphological analysis.

Rachel demonstrated only partial familiarity with morphology, describing how she occasionally introduced prefixes or suffixes when new terms appeared but without any sustained focus. For example, she explained: *“I spend a wee bit of time with mine looking at prefixes, so you know, things like photo or sito or a suffix with kinesis.”* Here, *photo-* (as in *photograph*, meaning “light”) and *sito-* (from Greek *sitos*, meaning “grain” or “food,” as in *sitosterol*) are examples of Greek combining forms, which function as both prefixes and suffixes. Their inclusion illustrates Rachel’s limited morphological repertoire and a lack of precision in terminology, suggesting some conceptual confusion about how word parts are categorised and how they contribute to meaning.

While Rachel could provide occasional morphological explanations, she acknowledged that these were typically one-off moments rather than part of a deliberate instructional sequence.

“Breaking that word down at the start... but as I said, we’re not that good about going back to it sometimes. I’m not sure what else we do actually. That’s probably it.” The repeated use of “we” here indicates that this was not simply an individual habit but reflected a broader pattern across her department. Additionally, Rachel reflected on the depth of knowledge gap, revealing both her own uncertainty and significant variation in practice among colleagues. *“I think I do it, but I don’t know that I understand it that well. But I don’t know if my other staff do it either.”* As someone in a leadership position, she recognised that the issue was systemic rather than isolated, likely stemming from minimal professional learning in this area. *“Yeah, I’m not sure... I don’t know what I don’t know. But I’d be interested in PD around it. Specifically, science would be amazing because that doesn’t really happen.”* Her reflections demonstrate a systemic gap in both knowledge and practice, underscoring the need for targeted professional learning to move morphology from an occasional aside to an intentional and embedded part of science instruction.

These accounts reveal two distinct challenges. First, some participants were unfamiliar with the concept of morphology altogether or confused it with unrelated strategies, such as syllable segmentation or the use of analogies. Second, even among those with some understanding, there was significant uncertainty about how morphology could be taught effectively in science contexts. As a result, morphology instruction in these classrooms was limited, incidental, and unsupported by professional development or cross-curricular planning. Teachers expressed strong interest in using it more deliberately, but without greater conceptual clarity, explicit training, and structured guidance, its potential to support science vocabulary remains largely unrealised.

4.5. Theme 4: Teachers want practical, science-aligned morphology instruction with clear examples and support

Although participants currently reported using morphology informally and inconsistently, all four expressed strong interest in incorporating it more deliberately, provided that appropriate support and resources were available. Their enthusiasm, however, was often underpinned by good intentions rather than secure knowledge. Participants showed only surface-level understanding of morphology and, in some cases, confusion about what it entails. Despite this, they were unanimous in their desire for practical strategies that could be easily integrated into existing teaching routines. They emphasised that any morphology initiative would need to be manageable, efficient, and directly linked to the science content they were already expected to deliver.

Sarah described her ideal morphology programme as one that fit seamlessly into the science units she already taught: *“It would need to be easy to slot into what we already do, so not something that feels like a whole new subject.”* She suggested *“short, consistent lessons before we start a unit that introduce the key word parts”* and emphasised the value of shared resources: *“Even if we had a shared bank of science terms broken into morphemes, it would make a big difference.”* Her comments reflected a clear desire for immediate, usable tools, while also showing a limited confidence in independently designing morphological instruction.

Moana also valued structure and planning support, proposing a scope and sequence that would align word part instruction with science topics: *“Maybe even a structured plan of which vocabulary words we’re going to cover and when... it would be really interesting to have a big list of words that students should know by the time they hit each year-level.”* While Moana’s suggestion of year-level word lists could help teachers plan instruction and ensure cumulative coverage of key terms, lists alone should not determine morphological teaching. Rather, they should serve as a scaffold to guide the introduction of meaningful morphemes, integrated into broader instruction that focuses on how word parts combine to create scientific meaning. Used in this way, curated word

lists could provide the backbone for short, embedded instructional routines, giving teachers a clear starting point while still allowing them to focus on deeper word analysis and application. For Moana, the real value of such resources lay not in the lists themselves, but in how they could translate into practical, repeatable classroom practices that felt achievable within the constraints of a busy science curriculum. She saw short, embedded routines as manageable, particularly if supported by ready-made posters, digital resources, or model lessons. Like Sarah, she stressed the need for clear demonstrations. *“I think I would just do it at the start of each lesson for five or ten minutes because it doesn’t need to be massive... it would just become part of your everyday teaching.”*

Although Anita admitted she had not encountered the term *morphology* before the interview, she was still eager to try a structured approach, provided it included concrete examples and demonstrations. This suggests that teacher openness to new approaches does not necessarily depend on existing knowledge, but rather on how accessible and practical the approach feels within their current teaching context. She repeatedly emphasised her need for modelling. *“Just examples, I think. Just examples of real-life teaching so that you can then try it... videos of it in practice would be great.”* While her responses revealed uncertainty about what morphology is, they also showed her willingness to adopt new strategies, provided they were supported by clear modelling and adaptable materials.

Rachel was similarly enthusiastic but framed her ideal programme in pragmatic terms, stressing the need for usability and workload management. *“I think anything that goes over common prefixes and suffixes in science or where the derivative comes from that’s linked to images I think could be quite powerful.”* She explained that it would need to be embedded without adding extra marking or preparation: *“...something topic related that you could do near the start of a topic and reuse it throughout the unit... Because then it’s just a short activity rather than something that’s very labour intensive.”* Her emphasis on minimal additional workload suggests that practical constraints, such as limited time and competing curriculum demands, significantly shape teachers’

willingness to adopt new approaches. It also points to gaps in pedagogical content knowledge (PCK), where teachers may feel uncertain about designing morphology-focused tasks without structured support. In line with this desire for efficiency, Rachel valued digital integration, suggesting that embedding resources into existing platforms like Google Classroom would make morphology instruction easier to deliver and sustain.

These perspectives point to a shared vision for a morphology programme that is embedded in science instruction rather than added on. Participants wanted approaches that were clear, flexible, and ready to use, with modelling and resources that reduced preparation demands. However, their reliance on external supports rather than teacher-driven expertise revealed additional tensions. While they were eager to apply morphology, many lacked the confidence and conceptual understanding needed to design instruction independently. At the same time, the emphasis on pre-prepared materials suggested that even when teachers understood the potential value of morphology, competing demands on their time made them reluctant, or unable, to allocate significant effort to resource development. Together, these tensions demonstrate the importance of professional learning that builds both knowledge and capacity, while also providing practical tools to make implementation realistic within classroom constraints.

4.6. Theme 5: Structural constraints and disciplinary perceptions limit literacy integration in science

While participants expressed strong interest in strengthening vocabulary and morphology instruction, their ability to act on that interest was constrained by a range of structural, conceptual, and teacher-level barriers. These included limited instructional time, competing curriculum demands, and deeply embedded perceptions of literacy and science as separate disciplines. This last point is particularly significant. Several participants did not appear to view language as *inherent* to scientific practice but rather as an *addition* to it. Such perceptions, combined with a lack of professional development connecting literacy theory to science pedagogy, meant that language

instruction was often treated as optional, supplementary, or external to science teaching rather than integral to its purpose.

Sarah emphasised that systemic factors, rather than a lack of willingness, often restricted the integration of literacy into science. She described how subject boundaries were reinforced in practice: *“It’s almost like literacy is its own little world, and then science is another one. Unless you’re really intentional about bringing them together, they just stay separate.”* Her comment reflects not only a structural reality, where timetables, planning, and departmental expectations keep subjects isolated, but also a conceptual barrier. Teachers often internalised these divisions, implicitly framing literacy as a transferable set of skills that *belong elsewhere* rather than as a central component of discipline-specific work. In this view, vocabulary instruction is perceived as something *added on* to science, rather than part of what it means to do science itself.

This separation was reinforced by curriculum expectations and time pressures, which left little room to prioritise language work. As Sarah explained: *“There’s just not enough time. You’re trying to get through all the science content, and then vocabulary feels like something extra rather than part of it.”* Her comment points to a fundamental misalignment between how science is taught and how it is understood. Instead of recognising scientific vocabulary as the *language of the discipline*, a tool for constructing, representing, and communicating knowledge, teachers often viewed it as competing with content rather than enabling its comprehension. This framing helps explain why literacy instruction remained peripheral, even when teachers acknowledged its importance. For Sarah, the problem was not a lack of motivation but rather the absence of systemic structures, curriculum guidance, and shared pedagogical frameworks that connect language and science in a sustained, meaningful way.

Moana highlighted how contact time shaped her practice. *“In my literacy class we definitely differentiate a bit more, but when we’re only teaching science for three times a week for that 45*

minutes, I probably don't differentiate enough for those students.” Her comments revealed how science teaching, constrained by limited instructional time and pressured by curriculum coverage, often reduced opportunities to integrate literacy strategies, even when teachers were aware of their importance. Anita similarly described a lack of cross-curricular alignment, noting that while homeroom inquiry often integrated reading and writing with science topics, specialist science remained isolated.

It would be good for all teachers... because you are, often the enquiry topic is science. And then you've got your language associated with that, so then your writing is associated with that. It's a lot more integrated. We endeavour to do that here, but our specialist subjects are very separate.

This separation reflects more than scheduling constraints; it highlights a widespread perception that literacy and science are distinct domains rather than mutually reinforcing. Participants did not consistently view language as integral to disciplinary learning but instead positioned it as an *addition* to science, rather than as the medium through which scientific Knowledge is constructed and communicated.

Rachel reinforced these concerns, emphasising timetabling as a persistent constraint: *“With our Year 7 to 9 classes, we only see them twice a week...and it's just not enough.”* She explained that heavy content demands meant new approaches had to be efficient and easy to implement if they were to be viable within existing structures. These reflections highlight how limited teaching hours, workload pressures, and entrenched curriculum expectations overshadow teachers’ intentions to integrate literacy more fully. Crucially, they also reveal a deeper issue. Because language is not necessarily recognised as *part of* science, vocabulary instruction continues to be seen as optional rather than essential. This mindset limits its integration into classroom practice.

Collectively, these accounts point to a combination of structural and teacher-related barriers that limit the integration of literacy into science instruction. Structurally, timetabling constraints,

curriculum demands, and the separation of literacy from specialist subjects restricted opportunities for teachers to embed vocabulary and morphology consistently across learning areas. At the same time, teacher-related factors compounded these challenges. While participants recognised the potential of cross-curricular approaches, they often framed solutions in terms of ready-made programmes or externally provided resources rather than developing their own conceptual knowledge of morphology. They also tended to view science as a distinct subject rather than a language-rich discipline, which further discouraged the integration of vocabulary instruction as part of science teaching itself. This reliance on external structures reflects not only the dual pressures of heavy workloads and limited professional development opportunities, but also a lack of confidence in designing and implementing morphology-focused instruction independently. Consequently, the integration of literacy into science remains fragmented, not because of teacher resistance, but because systemic conditions, entrenched disciplinary perceptions, and shallow professional knowledge interact to restrict sustainable practice. For integration to succeed, both the structural supports and the development of teacher expertise must be addressed in tandem.

4.7 Summary

The five themes together reveal a nuanced and often challenging picture of how science vocabulary and morphology are understood and taught in intermediate classrooms. Participants consistently recognised that discipline-specific vocabulary is central to science learning and achievement. Yet they also observed that students frequently struggled to use these terms accurately, even when they appeared to understand the underlying concepts. Instructional responses to this challenge were highly variable and often informal. Word walls, vocabulary lists, and incidental explanations were common, but structured, system-wide approaches were noticeably absent. Teacher related factors, such as limited pedagogical knowledge, low confidence, and misconceptions about the relationship between language and science, further contributed to this inconsistency.

Morphology emerged as a tool with strong potential but limited current use. Participants expressed interest in teaching word parts, yet their understanding was often shallow or confused. Morphological instruction tended to occur opportunistically, usually in response to a difficult word, rather than as part of deliberate, sustained teaching. The reasons for this were multifaceted. Gaps in knowledge, a lack of professional development, and few examples of effective practice all contributed to participants' uncertainty. Despite these challenges, participants were enthusiastic about the idea of a practical, science-aligned programme. They valued ready-made routines, clear demonstrations, and shared resources that could be integrated into lessons without significant extra planning.

Structural barriers also limited participants' capacity to act on this interest. Pressures such as restricted teaching time, competing curriculum demands, and the entrenched separation of literacy and science reduced opportunities for consistent vocabulary and morphology instruction. The findings therefore point to a dual need; to strengthen teachers' knowledge and confidence, and to provide system-level supports that make literacy integration realistic and sustainable. Only when expertise and structure develop together will vocabulary and morphology become integral, rather than peripheral, to science instruction at the intermediate level.

Chapter 5: Discussion

Aim of the Study

This study investigated how Year 7 and 8 teachers in Aotearoa New Zealand understand and use morphology-based instruction to support students' comprehension of scientific vocabulary. In this thesis, morphology-based instruction refers to teaching practices that help learners identify meaningful word parts and use this knowledge to interpret scientific terms. The study also examined the conditions that enable or constrain morphology-based instruction. It explored the design principles teachers believe are necessary for a programme that is feasible, sustainable, and aligned with CLT. These findings inform the development of an instructional approach that is theoretically grounded and responsive to the linguistic demands of science, while remaining workable within the realities of intermediate classrooms.

Research Questions

The study addressed the following research questions:

1. How do Year 7 and 8 teachers conceptualise morphology and its role in science literacy?
2. How do teachers currently integrate morphology-based instruction in science?
3. What conditions enable or constrain the use of morphology-based instruction in science?
4. What instructional design principles and supports do teachers identify as necessary for developing and implementing a morphology-based programme that is feasible, sustainable, and aligned with Cognitive Load Theory?

5.1 Research Question 1: How do Year 7 and 8 teachers conceptualise morphology and its role in science literacy?

Participants consistently recognised vocabulary as central to student success in science. This reflects wider research showing that discipline-specific understanding depends heavily on

specialised language (Fang & Schleppegrell, 2010; Snow, 2010). However, this recognition was often superficial. Participants noted that students experienced difficulties with scientific words but did not examine why these difficulties occurred or how their instructional decisions contributed to them. This pattern aligns with research showing that teachers typically value vocabulary instruction but tend to rely on definitional or incidental approaches rather than methods that build transferable word-learning strategies (Graves, 2016).

At the same time, the literature demonstrates that many teachers lack the linguistic and pedagogical knowledge required to teach word structure effectively (Kirby & Bowers, 2017; Moats, 2020). In this study, this gap contributed to the morphologically dense nature of scientific vocabulary receiving little explicit attention. As a result, teachers were limited in their capacity to support students with unfamiliar Tier 2 and Tier 3 terms, particularly those containing embedded conceptual relationships. This echoes wider evidence that morphological complexity can impede comprehension when learners are not supported to analyse how word parts contribute meaning (Nagy & Townsend, 2012; Snow, 2010).

This gap between valuing vocabulary and understanding its internal logic shaped participants' instructional decisions. Teachers relied on exposure, repetition, and definitional clarification, operating from the belief that these practices were sufficient to support students' vocabulary learning. This reveals a gap between belief and practice. Such assumptions are common in classroom instruction and curriculum guidance, where academic vocabulary is often treated as something that develops through use rather than through explicit analysis (Beck et al., 2013; Graves, 2016). However, the findings suggest that these approaches do not address the linguistic features required for students to interpret unfamiliar scientific terms independently, a pattern widely documented in the literature (Goodwin & Ahn, 2013; Nagy & Townsend, 2012). By focusing on surface-level explanations rather than structural analysis, instruction inadvertently positions students as passive recipients of meaning rather than active interpreters of scientific language. This

misalignment suggests that current professional learning and curriculum guidance do not adequately equip teachers with the linguistic understanding required for science teaching, resulting in well-intentioned but incomplete approaches that leave the underlying causes of vocabulary difficulty unresolved.

Most participants conceptualised vocabulary as a set of discrete items to be memorised rather than as a network of meaning-bearing structures. As a result, morphemes were treated as occasional points of curiosity rather than systematic tools for accessing *difficult* scientific ideas. Given the highly multimorphemic nature of scientific vocabulary, this view limits the potential of morphology to support comprehension (Nagy & Townsend, 2012). By overlooking the way many scientific terms encode conceptual relationships within their morphemic components, participants inadvertently reduced vocabulary to labels rather than treating it as a pathway for students to develop disciplinary thinking. When teachers do not recognise how morphemes represent underlying scientific ideas, opportunities to connect linguistic form to conceptual understanding are lost. This suggests that the barriers to morphological instruction are conceptual as well as practical. Teachers are not simply lacking strategies but are operating from an instructional model in which words are endpoints rather than entry points to scientific meaning.

Participants also attributed students' difficulties to insufficient exposure rather than to the lack of explicit instruction in word structure. This reflects a broader misconception that academic language is acquired implicitly through immersion (Fang, 2006; Schleppegrell, 2004). Such assumptions underestimate the linguistic complexity of science texts, which include specialised meanings that differ from everyday usage. Without explicit instruction, students, particularly those with limited background knowledge, struggle to access scientific concepts (Beck et al., 2013; Nation, 2019). This indicates that participants' reliance on exposure-based approaches is not simply a matter of limited strategies. Rather, it reflects a deeper misunderstanding of how academic language develops. This conceptual gap helps explain why morphology remained incidental in

participants' practice and highlights the need for instructional guidance that makes word structure visible and teachable.

Participants' reliance on pronunciation or superficial definitions reflects a deeper structural issue. The current study suggests that teachers may lack the linguistic and pedagogical content knowledge required to support meaning-making in science. This is not merely a gap in technique but a curriculum-level vulnerability that restricts students' opportunities to engage with scientific ideas through language. The fact that participants defaulted to surface-level explanations suggests that current education and professional learning do not adequately prepare teachers for the linguistic demands of science (Bowers & Kirby, 2010; Moats, 2020). In practical terms, this results in students receiving labels without conceptual access, reinforcing Perfetti and Stafura's (2014) argument that weak lexical representations undermine comprehension. This limitation has pedagogical consequences because without robust morphological explanations, students are less likely to build the semantic networks needed for scientific reasoning.

Discipline-specific expectations also shaped conceptualisations. Although participants recognised the technicality of scientific language, many positioned explicit vocabulary or morphology instruction as the responsibility of English teachers. Such disciplinary divides reduce teachers' sense of ownership over the linguistic demands of their subject (Fang, 2006; Shanahan & Shanahan, 2008). When morphology is not viewed as integral to scientific meaning-making, opportunities to scaffold understanding are lost for students.

5.2 Research Question 2: In what ways do teachers currently integrate morphology-based instruction in science?

The conceptual limitations identified in RQ1 were reflected in participants' instructional decision-makings. Rather than functioning as a planned pedagogical strategy, morphology was used reactively, suggesting that participants lacked the confidence and conceptual frameworks needed to

teach word structure deliberately. This pattern reflects a broader challenge in discipline-specific literacy. The absence of explicit models or tools results in vocabulary instruction that is rarely woven systematically into subject teaching (Moats, 2020). The absence of planned morphological activity also illustrates how science lessons are often shaped by short-term problem-solving rather than long-term linguistic development.

One way in which short-term problem-solving shaped participants' science lessons was the tendency to focus on syllables rather than morphemes. This confusion shifted instructional attention away from meaning and toward surface-level pronunciation. Research shows that such misunderstandings are common when teachers have not received explicit training in word structure (Moats, 2020). Participants' accounts reflected this pattern, with several describing how they segmented scientific terms into pronounceable chunks rather than analysing their morphological components. For example, breaking *photosynthesis* into *pho-to-syn-the-sis* prioritises syllabification and conceals the conceptual architecture of the term (*photo* "light" + *synthesis* "put together"). A focus on decoding through syllables does more than obscure meaning. It reinforces the misconception that scientific vocabulary must be memorised rather than reasoned with. This practice also introduces unnecessary cognitive load because students must retain labels without access to analytical strategies that make terminology more transparent. Literature on generative vocabulary instruction and self-teaching processes supports this concern, showing that students need opportunities to analyse and generate meaningful connections between word parts to build durable lexical representations (Bowers & Kirby, 2010; Ehri, 2014; Share, 1995). In this way, inaccurate segmentation represents both a linguistic misunderstanding and a missed opportunity for conceptual learning.

Low confidence further restricted how participants incorporated morphology and influenced what they felt able to model for students. Their uncertainty about identifying morphemic components meant that teachers often avoided analysing terminology altogether, which limited the

range of explanations they were willing to provide. This reluctance reflects a broader structural issue in science education, where teachers are expected to introduce highly technical vocabulary without sufficient linguistic preparation (Moats, 2020). Under these conditions, definitional explanations became the default rather than deliberate instructional choices. Research indicates that such explanations support only shallow lexical representations (Goodwin & Ahn, 2013), and participants' accounts mirror this pattern. By relying on what they already knew, teachers unintentionally restricted opportunities to demonstrate how complex words can be systematically analysed. This suggests that gaps in linguistic knowledge not only constrain teachers' confidence but also shape the epistemic boundaries of what students are permitted to learn.

As a result, morphology was not seen as an intentional component of participants' practice. Participants did not integrate word-structure work as a regular feature of science lessons but instead addressed it sporadically when difficulties arose. The challenge was not simply the lack of strategies but the lack of supporting conditions that enable those strategies to function in real classrooms. Moving toward deliberate, conceptually grounded morphology instruction therefore requires building teachers' linguistic knowledge, providing models that demonstrate how to analyse scientific terms, and embedding routines that integrate word structure into scientific inquiry. Without these supports, the potential of morphology as a meaning-making tool remains unrealised.

5.3 Research Question 3: What conditions enable or constrain the use of morphology-based instruction in science?

Participants' ability to integrate morphology was shaped by a combination of structural, disciplinary, and knowledge-related conditions that interacted to determine what teachers felt was possible in science classrooms. These influences operated as overlapping pressures that collectively constrained the feasibility of systematic morphology instruction. Understanding these conditions is essential because they illuminate why morphology rarely featured as a regular, planned aspect of science teaching, even when participants recognised its potential.

Limited instructional time was a significant constraint, particularly for participants teaching specialist science classes who saw students only a few times per week. Under these conditions, vocabulary or morphology instruction was often perceived as competing with conceptual teaching rather than supporting it. This perception reveals a deeper issue. This perception reflects an implicit assumption that disciplinary language develops through exposure rather than instruction (Snow, 2010). Interpreted through a CLT lens, participants' accounts suggest that omitting vocabulary scaffolding is not a neutral omission but a pedagogical risk. When students are required to independently decode complex terminology, their cognitive resources are diverted away from conceptual understanding (Paas & Sweller, 2014; Sweller et al., 2019). Time constraints therefore do not simply limit instructional choices; they expose a fundamental misalignment between how scientific knowledge is taught and how learners process complex, morphologically dense language.

Disciplinary expectations reinforced these pressures. Many participants believed that vocabulary and word-structure instruction belonged to literacy teachers rather than science teachers. This belief reflects a broader pattern in education in which responsibility for language development is separated from content instruction, despite evidence that all subjects carry discipline-specific linguistic demands (Fang & Schleppegrell, 2010). Such a perspective overlooks the unique language features of scientific texts that differ significantly from everyday usage. Without explicit support, students must navigate these linguistic structures alone, which often leads to conceptual misunderstanding as well as language confusion (Fang, 2006).

Participants' limited morphological knowledge and reliance on definitional explanations compounded these structural pressures, making it difficult for them to position morphology as a generative meaning-making tool rather than a memorisation task. These gaps shaped not only what teachers felt confident to teach but also how they conceptualised the role of language within science. Without clarity about how morphemic units represent scientific ideas, participants tended to treat vocabulary as a series of labels rather than as conceptual resources. This orientation

constrained the potential of morphology to support reasoning, explanation, and interpretation, reinforcing the pattern in which scientific language was approached at a surface-level rather than analysed as part of disciplinary thinking.

Despite these constraints, some enabling conditions emerged. Several participants drew on routines associated with the iDeaL spelling framework, which provided predictable structures for word-level work. However, reliance on such routines is limited, as they were not designed for multimorphemic scientific vocabulary and were applied procedurally rather than conceptually. Without deeper linguistic understanding to guide their use, these routines risk reinforcing superficial engagement with words instead of supporting disciplinary meaning-making. This finding suggests that structural supports alone cannot compensate for gaps in linguistic and pedagogical knowledge. Unless teachers understand the conceptual purpose of morphological instruction, routines may offer efficiency but not effectiveness. The implication is that successful integration requires both well-designed tools and the pedagogical knowledge needed to use them flexibly, responsively, and in ways that advance scientific thinking.

These conditions indicate that the primary barriers to morphology integration were structural and epistemic rather than motivational. Effective implementation will require system-level supports that strengthen participants' morphological knowledge, align literacy and science goals, and protect space for language-focused routines within science instruction. Without these supports, morphology is unlikely to shift from an incidental add-on to a core meaning-making resource in science learning.

5.4 Research Question 4: Instructional Design Principles and Supports Needed for a Feasible and CLT-Aligned Programme

Participants identified several design principles that would support the integration of morphology into science instruction in sustainable and meaningful ways. Although they did not

reference theory explicitly, their preferences aligned closely with the principles of Cognitive Load Theory and reflected an intuitive understanding of the cognitive demands placed on learners when working with scientific vocabulary.

A key design principle identified by participants was the use of short, predictable routines that could be woven into science lessons without disrupting conceptual teaching. Such routines align with Cognitive Load Theory's emphasis on managing intrinsic and extraneous cognitive load through small, predictable instructional units (Sweller et al., 2019). However, predictability does not guarantee conceptual depth. Routines can quickly become procedural if teachers lack the underlying linguistic knowledge required to adapt them to scientific vocabulary. Research on effective morphology instruction shows that routines only become generative when they require students to analyse, compare, and manipulate meaningful word parts rather than recite definitions (Bowers & Kirby, 2010; Goodwin & Ahn, 2013). Science literacy research similarly emphasises that instructional approaches must make the links between linguistic form and scientific meaning explicit if students are to build durable conceptual understanding (Fang & Schleppegrell, 2010). Participants valued routines because they felt manageable. This preference may also reflect a pragmatic response to systemic pressures rather than a pedagogically driven understanding of how morphological reasoning develops. The challenge, therefore, is not only to create feasible routines but to ensure they support generative word learning rather than reinforcing surface-level engagement with scientific terminology.

Explicit modelling emerged as an essential component of effective morphological instruction. Participants wanted to see demonstrations of how morphological analysis could be enacted within scientific contexts, including how to break down complex terms and how related words can be used to build conceptual networks. Modelling was valued because it reduced uncertainty, offered clarity about what morphology looks like in practice, and illustrated how word structure contributes to scientific meaning. This aligns with research showing that modelling is a

central feature of explicit instruction and is critical for helping educators move beyond definitional explanations toward generative, conceptually grounded teaching (Archer & Hughes, 2011; Goodwin & Ahn, 2013).

Participants also emphasised the need for accurate, topic-aligned resources, including curated morpheme lists and reliable word breakdowns. These resources were seen as essential for reducing extraneous cognitive load by making linguistic structure visible and by removing the burden of independently analysing unfamiliar scientific terminology (Paas & Sweller, 2014). However, participants acknowledged that resources alone are insufficient. Without deeper conceptual understanding of morphology, even well-designed materials risk leading to superficial implementation rather than meaningful instructional change.

Schoolwide coherence was identified as another enabling condition. Participants valued shared routines, consistent language across subjects, and collaborative approaches that helped students transfer morphological strategies between learning areas. However, many scientific terms carry discipline-specific meanings that do not generalise across subjects (Shanahan & Shanahan, 2008). Because of these differences, coherence must support strategic transfer while preserving discipline-specific precision. Shared practices also reduced workload by providing predictable structures. At the same time, participants recognised that coherence must be supported by substantive professional learning. Research shows that without adequate linguistic and pedagogical knowledge, teachers may adopt routines mechanically, resulting in procedural rather than conceptually grounded instruction (Bowers & Kirby, 2010; Moats, 2020).

These design principles reflect a balanced and theoretically informed vision for morphology-based instruction in science. Participants described an approach that integrates short, structured routines, explicit modelling, accurate and contextually relevant resources, and

schoolwide coherence to support sustainability. Each of these elements contributes to an instructional environment that is both feasible for teachers and cognitively supportive for students.

5.5 Implications for Morphology-Based Science Instruction

The findings across this study indicate that an effective morphology-based approach to science instruction must operate across four interconnected levels: instructional design, teacher expertise, system structures, and sustainability. These levels reflect the wider implications of the study by highlighting both the complexity of classroom practice and the limitations of approaches that focus on isolated strategies without addressing the broader organisational conditions in which teachers work. Although the programme principles draw on research and teacher perceptions, they remain conceptual rather than empirically validated. This creates a central tension: participants identified what appears feasible within current constraints, yet what is feasible may not be sufficient to support the depth of linguistic and conceptual learning required in science. The four-level framework therefore represents a theoretically grounded starting point for programme design, but one that requires further development and empirical testing to determine its effectiveness in practice.

5.5.1 Instructional Principles for Student Learning

Students require explicit instruction in how scientific terms are constructed and how morphemic units carry meaning. Participants' reports suggested that their students rarely receive systematic support to interpret word structure, despite the morphologically dense nature of scientific vocabulary. Instruction should therefore begin with transparent morphemes, where meanings map clearly onto whole words, before progressing to more conceptually opaque Greek and Latin combining forms that frequently appear in science. Such sequencing supports the gradual management of intrinsic cognitive load by reducing the number of unfamiliar elements students must process simultaneously, while building accuracy and confidence over time (Carlisle, 2010; Kieffer & Lesaux, 2012).

The use of morphological families also strengthens vocabulary learning. Grouping scientific terms by common bases or combining forms helps students form semantic networks and transfer learning across curriculum units (Rasinski et al., 2011). Regular opportunities for students to articulate how morphemes contribute to meaning are intended to encourage deeper processing and expose misconceptions that may impede conceptual understanding. This is especially important in science, where terminology encodes conceptual relationships that students must identify to build schema.

Multilingual learners benefit further when instruction draws on patterns and cognates (Kieffer & Lesaux, 2008). Taken together, these insights highlight that instructional design must provide systematic, generative, and conceptually grounded opportunities for students to reason with morphemes, rather than relying on incidental encounters with complex terminology. This directly responds to the patterns identified in RQ4, where vocabulary work was often incidental, definitional, and disconnected from deeper meaning-making.

5.5.2 Teacher Expertise and Pedagogical Enactment

Participants' limited linguistic and pedagogical content knowledge constrained their ability to model morphological analysis in ways that supported scientific meaning-making. A morphology-based programme must therefore include targeted professional learning that builds both conceptual understanding and instructional skill. Teachers require explicit instruction in the structure of English words, including the prevalence and function of Greek and Latin forms in scientific vocabulary, as well as opportunities to practise analysing terms and delivering brief, consistent routines.

Practice-based professional learning is essential. Approaches that incorporate rehearsal, demonstration lessons, collaborative planning, and observation help teachers integrate morphology into science instruction in realistic and sustainable ways (Desimone & Garet, 2015; Timperley et

al., 2007). Crucially, conceptual clarity and pedagogical modelling must develop together so teachers are able to move beyond definitional explanations and adopt generative, analytic approaches that support scientific understanding. This directly addresses earlier findings that, without adequate knowledge, teachers may adopt routines mechanically, leading to procedural rather than conceptually grounded instruction. In this way, teacher expertise becomes a central lever for ensuring that morphological routines genuinely support comprehension rather than simply adding another task.

5.5.3 System-Level Principles for Coherent Implementation

Morphology must be embedded within school and system structures to ensure consistent and conceptually aligned implementation. This suggests that while participants identified approaches that appear feasible within current constraints, feasibility alone may be insufficient to support the depth of linguistic and conceptual learning required for scientific understanding. Schoolwide planning templates, unit outlines, and explicit leadership support can help make morphological instruction visible, expected, and manageable across science programmes. When morphology remains optional or peripheral, teachers are less likely to integrate it consistently, particularly under time pressure, a constraint repeatedly emphasised by participants.

Cross-curricular coherence further strengthens student learning. Many scientific terms have specialised meanings that differ from everyday usage, and academic words used across subjects often shift subtly in meaning (Nagy & Townsend, 2012). When learning areas reinforce shared morphemes or clarify meaning changes across contexts, students encounter aligned linguistic patterns that support vocabulary network development and reduce confusion. This responds to the findings that science and literacy were often treated as separate domains, limiting opportunities to build shared language resources.

Participants noted that curated word lists and reliable breakdowns can reduce workload, yet research cautions that resources alone do not produce instructional change (Kennedy, 2016). System supports must therefore balance efficiency with conceptual depth, ensuring that morphology is implemented in ways that are accurate, generative, and explicitly linked to scientific meaning-making rather than reduced to isolated tasks. This reflects the need, identified in the findings, for frameworks that guide practice without becoming rigid scripts.

5.5.4 Sustainability and Capacity Building

Long-term sustainability refers to the extent to which morphology-based practices can be maintained and refined over time, rather than disappearing once initial enthusiasm, external support, or key individuals move on. Participants raised concerns about workload, staff turnover, and the fragility of initiatives. A sustainable programme must therefore be manageable within existing time constraints, supported by ongoing professional learning, and embedded in school systems so that it does not depend on one teacher or leader.

Developing internal capacity is central to this. Staff turnover, timetable pressures, and shifting curricular priorities can quickly erode isolated initiatives unless shared responsibility and distributed leadership are established. Collaborative development of resources, co-planning, and opportunities for teachers to model routines for each other help embed morphology within school culture and mitigate the risk that knowledge leaves with individual staff members.

Participants also emphasised that sustainability depends on teachers understanding *why* morphology is valuable. When teachers recognise how morphological instruction reduces extraneous cognitive load, strengthens schema formation, and facilitates conceptual learning, they are more likely to maintain routines even during periods of high workload. Sustainable approaches must therefore remain simple, predictable, and cognitively purposeful. Overly complex systems are unlikely to be adopted consistently, whereas clear routines aligned with conceptual understanding

are more feasible to sustain. In this way, sustainability is not an abstract add-on but the cumulative outcome of instructional design, teacher expertise, and system structures working together.

Collectively, these programme principles outline an approach that responds to the linguistic demands of science, supports teacher learning, and establishes coherent structures that enable meaningful and enduring integration of morphology into science instruction. They also demonstrate a clear line of sight from the literature to the findings and into programme design, strengthening the coherence of the overall conceptual framework.

Chapter 6: Conclusion, Strengths, Limitations, and Future Directions

6.1 Summary of Key Findings and Implications

This study examined how teachers conceptualise and use morphology within science instruction and explored the conditions that shape its integration. Participants recognised the linguistic demands of science but lacked the conceptual knowledge, pedagogical strategies, and structural support needed to teach word structure in generative ways. Although teachers valued vocabulary instruction, their reliance on definitional explanations and limited understanding of morphemic structure constrained students' opportunities to engage meaningfully with scientific terminology.

Despite these challenges, participants were open to incorporating explicit morphological instruction when supported by modelling, predictable routines, and accurate, topic-aligned resources. The programme principles developed from this study respond directly to these realities. They offer a theoretically grounded foundation for designing morphology-based science instruction, while also highlighting an important distinction between what teachers currently view as feasible within existing constraints and what may be required to support deeper linguistic and conceptual learning in science.

Conceptually, the study aligns with established theories of reading and learning, including the Simple View of Reading (Gough & Tunmer, 1986), orthographic mapping (Ehri, 2014), the self-teaching hypothesis (Share, 1995), and Cognitive Load Theory (Sweller et al., 2019). Teachers' observations of students who could pronounce scientific terms but not explain them illustrate the gap between word recognition and language comprehension. From a cognitive load perspective, students who encounter multimorphemic terms without explicit scaffolding may experience cognitive overload, reducing their capacity to grasp scientific ideas. These insights highlight morphology's potential to serve as both a cognitive and linguistic scaffold for making science vocabulary more accessible.

6.2 Strengths and Limitations

6.2.1 Strengths

A strength of this study is its focus on a critical but under-examined aspect of disciplinary literacy in upper primary and intermediate science. By investigating how teachers conceptualise morphology and its role in science vocabulary, the study contributes to a growing but still limited body of research on linguistic knowledge in science education. The use of in-depth, reflexive thematic analysis enabled a nuanced understanding of how teachers make sense of linguistic complexity and how structural, disciplinary, and pedagogical conditions intersect to shape their practice. In addition, the study offers a conceptual framework that connects research on morphology, science learning, and cognitive load, providing a theoretically grounded basis for future instructional design.

6.2.2 Limitations

Several limitations influence the interpretation and transferability of the findings. First, the small and geographically localised sample limits generalisability. The participating teachers worked within organisational, cultural, and curriculum contexts that may differ from those in other regions, meaning the findings should be interpreted as situated rather than universal.

Second, the study relied solely on teacher self-reports. Although interviews provide valuable insight into teachers' beliefs and reasoning, they do not necessarily reflect enacted practice. Participants may unintentionally idealise or underestimate aspects of their instruction due to recall bias, social desirability, or limited metacognitive awareness of their own linguistic decision-making. As a result, the patterns identified may represent approximations rather than precise descriptions. A more robust design would triangulate interview data with classroom observations, instructional artefacts, or student work samples to provide a fuller account of practice.

Finally, the programme principles proposed in this study are conceptual rather than empirically validated. They reflect teachers' perceptions of feasibility, not demonstrated impact on student learning. Further research is required to determine whether morphology-based instruction, when implemented according to these principles, improves comprehension of scientific vocabulary or reduces cognitive load during science learning.

6.3 Future Directions

Future research should investigate the impact of morphology-based instruction on student outcomes in science, including vocabulary knowledge, conceptual understanding, and cognitive load. Intervention and longitudinal designs would allow researchers to examine how morphological strategies develop over time and how they influence students' engagement with increasingly complex scientific texts. Such work would also help clarify whether the conceptual framework proposed here translates into tangible improvements in learning.

Further work is also needed to identify how professional learning can best support teachers in developing the linguistic and pedagogical knowledge required for morphologically informed science instruction. Studies that explore collaborative models, coaching, and resource development may illuminate pathways for building system-level capacity. Investigating how teachers appropriate morphological knowledge into their disciplinary practice would be especially valuable.

Research should examine how morphology interacts with other dimensions of disciplinary literacy, such as text structure, multimodal representation, and scientific argumentation. Exploring these intersections would provide a more comprehensive account of how language mediates conceptual learning in science and how a morphology-based approach might complement broader literacy initiatives within the discipline.

Finally, it is important to acknowledge that reflexive thematic analysis positions the researcher as an active interpreter of the data. My professional background in literacy and science

education inevitably shaped the analytic lens. This influenced which patterns were foregrounded and how findings were theorised. While reflexive strategies were used throughout the analysis to interrogate assumptions and enhance transparency, the interpretations presented here represent one situated reading of the data rather than a definitive account. Future research involving diverse analytic perspectives, alternative methodological approaches, or mixed-methods designs could extend, challenge, or refine these interpretations, contributing to a more comprehensive understanding of morphology-based instruction in science.

6.4 Conclusion

This study demonstrates that while teachers recognise the challenges posed by scientific vocabulary, they require deeper linguistic knowledge, clearer pedagogical models, and stronger system supports to integrate morphology meaningfully into science instruction. Morphology holds significant potential to reduce cognitive load, strengthen conceptual understanding, and make disciplinary language more transparent for learners. Realising this potential will require both structural commitment and pedagogical expertise. By foregrounding the linguistic nature of science, this thesis contributes to an emerging field of research focused on ensuring that all students can access the language of science and participate fully in disciplinary thinking.

References

- Adams, M. J. (1990). *Beginning to read: Thinking and learning about print*. MIT Press.
- Apel, K. (2014). A comprehensive definition of morphological awareness: Implications for assessment. *Topics in Language Disorders, 34*(3), 197–209.
<https://doi.org/10.1097/TLD.0000000000000019>
- Apel, K. (2022). A different view of the Simple View of Reading. *Remedial and Special Education, 43*(6), 434–447. <https://doi.org/10.1177/07419325211063487>
- Apel, K., Brimo, D., Diehm, E., & Apel, L. (2013). Morphological awareness intervention with kindergarteners and first- and second-grade students from low socioeconomic status homes: A feasibility study. *Language, Speech, and Hearing Services in Schools, 44*(2), 161–173. [https://doi.org/10.1044/0161-1461\(2012/12-0042\)](https://doi.org/10.1044/0161-1461(2012/12-0042))
- Apel, K., Wilson-Fowler, E. B., Brimo, D., & Perrin, N. A. (2012). Metalinguistic contributions to reading and spelling in second- and third-grade students. *Reading and Writing, 25*(6), 1283–1305. <https://doi.org/10.1007/s11145-011-9317-8>
- Aronoff, M., & Fudeman, K. (2011). *What is morphology?* (2nd ed.). Wiley-Blackwell.
- Avvisati, F., & Givord, P. (2023). The learning gain over one school year among 15-year-olds: An international comparison based on PISA. *Labour Economics, 84*, Article 102365.
<https://doi.org/10.1016/j.labeco.2023.102365>
- Baddeley, A. D. (2010). Working memory. *Current Biology, 20*(4), R136–R140.
<https://doi.org/10.1016/j.cub.2009.12.014>
- Bayat, N., Şekercioğlu, G., & Bakır, S. (2014). The relationship between reading comprehension and success in science. *Education and Science, 39*(176), 457–466.
<https://doi.org/10.15390/EB.2014.3693>
- Beck, I. L., McKeown, M. G., & Kucan, L. (2002). *Bringing words to life: Robust vocabulary instruction*. Guilford Press.
- Beck, I. L., McKeown, M. G., & Kucan, L. (2013). *Bringing words to life: Robust vocabulary instruction* (2nd ed.). Guilford Press.
- Berger, R. (2015). Now I see it, now I don't: Researcher's position and reflexivity in qualitative research. *Qualitative Research, 15*(2), 219–234.
<https://doi.org/10.1177/1468794112468475>
- Best, R. M., Floyd, R. G., & McNamara, D. S. (2008). Differential competencies contributing to children's comprehension of narrative and expository texts. *Reading Psychology, 29*(2), 137–164. <https://doi.org/10.1080/02702710801963951>
- Biemiller, A., & Slonim, N. (2001). Estimating root word vocabulary growth in normative and advantaged populations: Evidence for a common sequence of vocabulary acquisition. *Journal of Educational Psychology, 93*(3), 498–520.
<https://doi.org/10.1037/0022-0663.93.3.498>
- Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research, 26*(13), 1802–1811. <https://doi.org/10.1177/1049732316654870>

- Bishop, R. (1996). *Collaborative research stories: Whakawhanaungatanga*. Dunmore Press.
- Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7–74.
<https://doi.org/10.1007/s11092-008-9068-5>
- Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, 21(1), 5–31.
<https://doi.org/10.1007/s11092-008-9068-5>
- Bowers, P. N., & Kirby, J. R. (2010). Effects of morphological instruction on vocabulary acquisition. *Reading and Writing*, 23(5), 515–537.
<https://doi.org/10.1007/s11145-009-9172-z>
- Bowers, P. N., Kirby, J. R., & Deacon, S. H. (2010). The effects of morphological instruction on literacy skills: A systematic review of the literature. *Review of Educational Research*, 80(2), 144–179. <https://doi.org/10.3102/0034654309359353>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, Vol. 2: Research designs: Quantitative, qualitative, neuropsychological, and biological* (pp. 57–71). American Psychological Association.
<https://doi.org/10.1037/13620-004>
- Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 589–597.
<https://doi.org/10.1080/2159676X.2019.1628806>
- Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, 18(3), 328–352.
<https://doi.org/10.1080/14780887.2020.1769238>
- Carlisle, J. F. (2000). Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing*, 12(3), 169–190.
<https://doi.org/10.1023/A:1008131926604>
- Carlisle, J. F. (2003). Morphology matters in learning to read: A commentary. *Reading Psychology*, 24(3–4), 291–322. <https://doi.org/10.1080/02702710390227369>
- Carlisle, J. F. (2010). Effects of instruction in morphological awareness on literacy achievement: An integrative review. *Reading Research Quarterly*, 45(4), 464–487.
<https://doi.org/10.1598/RRQ.45.4.5>
- Carlisle, J. F., & Stone, C. A. (2005). Exploring the role of morphological awareness in reading achievement. *Reading & Writing*, 18(3), 269–292. <https://doi.org/10.1598/RRQ.40.4.3>
- Castles, A., Rastle, K., & Nation, K. (2018). Ending the reading wars: Reading acquisition from novice to expert. *Psychological Science in the Public Interest*, 19(1), 5–51.
<https://doi.org/10.1177/1529100618772271>
- Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, 8(4), 293–332. https://doi.org/10.1207/s1532690xci0804_2

- Collins, C. S., & Stockton, C. (2022). The theater of qualitative research: The role of the researcher/actor. *International Journal of Qualitative Methods*, 21, 1–9. <https://doi.org/10.1177/16094069221103109>
- Connor, C. M., Day, S. L., Zargar, E., Wood, T. S., Taylor, K. S., Jones, M. R., & Hwang, J. K. (2019). Building word knowledge, learning strategies, and metacognition with the Word-Knowledge e-Book. *Computers & Education*, 128, 284–311. <https://doi.org/10.1016/j.compedu.2018.09.016>
- Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences*, 24(1), 87–114. <https://doi.org/10.1017/S0140525X01003922>
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE.
- Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry & research design: Choosing among five approaches* (4th ed.). SAGE.
- Cromley, J. G. (2009). Reading achievement and science proficiency: International comparisons from the Programme for International Student Assessment. *Reading Psychology*, 30(2), 89–118. <https://doi.org/10.1080/02702710802274903>
- Cromley, J. G., & Azevedo, R. (2007). Testing and refining the direct and inferential mediation model of reading comprehension. *Journal of Educational Psychology*, 99(2), 311–325. <https://doi.org/10.1037/0022-0663.99.2.311>
- Cummins, J. (2000). *Language, power, and pedagogy: Bilingual children in the crossfire*. Multilingual Matters.
- Cunningham, A. E. (2006). Accounting for children's orthographic learning while reading text: Do children self-teach? *Journal of Experimental Child Psychology*, 95(1), 56–77. <https://doi.org/10.1016/j.jecp.2006.03.008>
- DeLeeuw, K. E., & Mayer, R. E. (2008). A comparison of three measures of cognitive load: Evidence for separable measures of intrinsic, extraneous, and germane load. *Journal of Educational Psychology*, 100(1), 223–234. <https://doi.org/10.1037/0022-0663.100.1.223>
- Desimone, L. M., & Garet, M. S. (2015). Best practices in teachers' professional development in the United States. *Psychology, Society, & Education*, 7(3), 252–263. <https://doi.org/10.25115/psyse.v7i3.515>
- Education Review Office. (2019). *Pacific strategy: A coordinated approach to improving Pacific learner outcomes 2019–2022*. Education Review Office. <https://www.ero.govt.nz/sites/default/files/2021-04/Pacific%20Strategy.pdf>
- Education Review Office. (2021). *Science in the New Zealand curriculum: Growing curiosity – Teaching strategies to engage years 5 to 11 students*. Education Review Office. <https://evidence.ero.govt.nz/media/fqxiqsb/ero-19844-science-growing-curiosity-years-5-11-report-v5-web.pdf>
- Ehri, L. C. (1995). Phases of development in learning to read words by sight. *Journal of Research in Reading*, 18(2), 116–125. <https://doi.org/10.1111/j.1467-9817.1995.tb00077.x>

- Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading, 9*(2), 167–188. https://doi.org/10.1207/s1532799xssr0902_4
- Ehri, L. C. (2014). Orthographic mapping in the acquisition of sight word reading, spelling memory, and vocabulary learning. *Scientific Studies of Reading, 18*(1), 5–21. <https://doi.org/10.1080/10888438.2013.819356>
- Ehri, L. C. (2020). The science of learning to read words: A case for systematic phonics instruction. *Reading Research Quarterly, 55*(S1), S45–S60. <https://doi.org/10.1002/rrq.334>
- Ehri, L. C., & McCormick, S. (1998). Phases of word learning: Implications for instruction with delayed and disabled readers. *Reading & Writing Quarterly, 14*(2), 135–163. <https://doi.org/10.1080/1057356980140202>
- Ehri, L. C., & Wilce, L. S. (1985). Movement into reading: Is the first stage of printed word learning visual or phonetic? *Reading Research Quarterly, 20*(2), 163–179. <https://doi.org/10.2307/747753>
- Fang, Z. (2006). The language demands of science reading in middle school. *International Journal of Science Education, 28*(5), 491–520. <https://doi.org/10.1080/09500690500339092>
- Fang, Z. (2008). Going beyond the Fab Five: Helping students cope with the unique linguistic challenges of expository reading in intermediate grades. *Journal of Adolescent & Adult Literacy, 51*(6), 476–482
- Fang, Z., Lamme, L. L., & Pringle, R. M. (2010). *Language and literacy in inquiry-based science classrooms, Grades 3–8*. Corwin Press.
- Fang, Z., & Schleppegrell, M. J. (2010). Disciplinary literacies across content areas: Supporting secondary reading through functional language analysis. *Journal of Adolescent & Adult Literacy, 53*(7), 587–597. <https://doi.org/10.1598/JAAL.53.7.6>
- Ford-Connors, E., & Paratore, J. R. (2015). Vocabulary instruction in the disciplines: Teaching and learning in context. *Harvard Educational Review, 85*(1), 50–70. <https://doi.org/10.1002/JAAL.00097>
- Glynn, S. M., & Muth, K. D. (1994). Reading and writing to learn science: Achieving scientific literacy. *Journal of Research in Science Teaching, 31*(9), 1057–1073. <https://doi.org/10.1002/tea.3660310915>
- Goodwin, A. P., & Ahn, S. (2010). A meta-analysis of morphological interventions: Effects on literacy achievement of children with literacy difficulties. *Annals of Dyslexia, 60*(2), 183–208. <https://doi.org/10.1007/s11881-010-0041-x>
- Goodwin, A. P., & Ahn, S. (2013). A meta-analysis of morphological interventions on literacy outcomes for students with literacy difficulties. *Annals of Dyslexia, 63*(1), 1–14. <https://doi.org/10.1080/10888438.2012.689791>
- Goodwin, A. P., Petscher, Y., Carlisle, J. F., & Mitchell, A. M. (2017). Exploring the dimensionality of morphological knowledge for adolescent readers. *Journal of Research in Reading, 40*(1), 91–117. <https://doi.org/10.1111/1467-9817.12064>
- Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7*(1), 6–10. <https://doi.org/10.1177/074193258600700104>

- Grant, C., & Osanloo, A. (2015). Understanding, selecting, and integrating a theoretical framework in dissertation research: Developing a “blueprint” for your house. *Administrative Issues Journal: Education, Practice, and Research*, 4(2), 12–26. <https://doi.org/10.5929/2014.4.2.9>
- Graves, M. F. (2016). *The vocabulary book: Learning and instruction* (2nd ed.). Teachers College Press.
- Grossoehme, D. H. (2014). Overview of qualitative research. *Journal of Health Care Chaplaincy*, 20(3), 109–122. <https://doi.org/10.1080/08854726.2014.925660>
- Guest, G., Namey, E., & Mitchell, M. (2017). *Collecting qualitative data: A field manual for applied research*. SAGE.
- Hackemann, T., Heine, L., & Höttecke, D. (2022). Challenging to read, easy to comprehend? Effects of linguistic demands on secondary students’ text comprehension in physics. *International Journal of Science and Mathematics Education*, 20(3), 43–68. <https://doi.org/10.1007/s10763-022-10306-1>
- Halliday, M. A. K., & Martin, J. R. (1993). *Writing science: Literacy and discursive power*. University of Pittsburgh Press.
- Hipkins, R. (2007). Assessing the key competencies: Why would we? How could we? *Curriculum Matters*, 3, 123–157.
- Hipkins, R., Bolstad, R., Baker, R., Jones, A., Barker, M., Bell, B., Coll, R., Cooper, B., Forret, M., Harlow, A., Taylor, I., France, B., & Haigh, M. (2002). *Curriculum, learning and effective pedagogy: A literature review in science education*. Ministry of Education. <https://www.nzcer.org.nz/sites/default/files/downloads/science-ed.pdf>
- Hjetland, H. N., Lervåg, A., Lyster, S.-A. H., Hagtvet, B. E., Hulme, C., & Melby-Lervåg, M. (2019). Pathways to reading comprehension: A longitudinal study from 4 to 9 years of age. *Journal of Educational Psychology*, 111(5), 751–763. <https://doi.org/10.1037/edu0000321>
- Hoover, W. A. (2023). The Simple View of Reading: Past, present, and future. *Reading and Writing*, 36(2), 207–228. <https://doi.org/10.1007/s11145-023-10471-x>
- Hoover, W. A., & Gough, P. B. (1990). The Simple View of Reading. *Reading and Writing*, 2(2), 127–160. <https://doi.org/10.1007/BF00401799>
- Hoover, W. A., & Tunmer, W. E. (2020). *The cognitive foundations of reading and its acquisition: A framework with applications connecting teaching and learning*. Springer. <https://doi.org/10.1007/978-3-030-44195-1>
- Hudson, M., & Russell, K. (2009). The Treaty of Waitangi and research ethics in Aotearoa. *Journal of Bioethical Inquiry*, 6(1), 61–68. <https://doi.org/10.1007/s11673-008-9127-0>
- Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational Psychologist*, 38(1), 23–31. https://doi.org/10.1207/S15326985EP3801_4
- Kieffer, M. J., & Lesaux, N. K. (2007). Breaking down words to build meaning: Morphology, vocabulary, and reading comprehension in the urban classroom. *The Reading Teacher*, 61(2), 134–144. <https://doi.org/10.1598/RT.61.2.3>

- Kieffer, M. J., & Lesaux, N. K. (2012). Direct and indirect roles of morphological awareness in the English reading comprehension of native English, Spanish, Filipino, and Vietnamese speakers. *Language Learning*, 62(4), 1170–1204. <https://doi.org/10.1111/j.1467-9922.2012.00722.x>
- Kirby, J. R. & Bowers, P. N. (2017). *Morphological instruction and literacy: Binding phonological, orthographic, and semantic features of words*. In K. Cain, D. L. Compton, & R. K. Parrila, (Eds.), *Theories of reading development* (pp 437-462). Amsterdam, NL: John Benjamins Publishing Company. <https://doi.org/10.1075/swll.15.24kir>
- Kraft, M. A., Blazar, D., & Hogan, D. (2018). The effect of teacher coaching on instruction and achievement: A meta-analysis of the causal evidence. *Review of Educational Research*, 88(4), 547–588. <https://doi.org/10.3102/0034654318759268>
- Kuo, L. J., & Anderson, R. C. (2006). Morphological awareness and learning to read: A cross-language perspective. *Educational Psychologist*, 41(3), 161–180. https://doi.org/10.1207/s15326985ep4103_3
- LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology*, 6(2), 293–323. [https://doi.org/10.1016/0010-0285\(74\)90015-2](https://doi.org/10.1016/0010-0285(74)90015-2)
- Lee, O., Quinn, H., & Valdés, G. (2013). Science and language for English language learners in relation to Next Generation Science Standards and with implications for Common Core State Standards for English language arts and mathematics. *Educational Researcher*, 42(4), 223–233. <https://doi.org/10.3102/0013189X13480524>
- Levin, I., & Ehri, L. C. (2009). Young children’s ability to read and spell their own and classmates’ names: The role of letter knowledge. *Scientific Studies of Reading*, 13(3), 249–273. <https://doi.org/10.1080/10888430902851422>
- Lonigan, C. J., Burgess, S. R., & Anthony, J. L. (2000). Development of emergent literacy and early reading skills in preschool children: Evidence from a latent-variable longitudinal study. *Developmental Psychology*, 36(5), 596–613. <https://doi.org/10.1037/0012-1649.36.5.596>
- Lonigan, C. J., Burgess, S. R., & Schatschneider, C. (2018). Examining the Simple View of Reading with elementary school children: Still simple after all these years. *Remedial and Special Education*, 39(5), 260–273. <https://doi.org/10.1177/0741932518764833>
- Mahar, N. E., & Richdale, A. (2008). *Primary teachers’ linguistic knowledge and perceptions of early literacy instruction*. *Australian Journal of Learning Difficulties*, 13(1), 17–37. <http://dx.doi.org/10.1080/19404150802093703>
- Masonheimer, P. E., Drum, P. A., & Ehri, L. C. (1984). Does environmental print identification lead children into word reading? *Journal of Reading Behavior*, 16(4), 257–271. <https://doi.org/10.1080/10862968409547520>
- McCutchen, D., Green, L., & Abbott, R. D. (2008). Children’s morphological knowledge: Links to literacy. *Reading Psychology*, 29(4), 289–314. <https://doi.org/10.1080/02702710801982050>

- Mercer, J. (2007). The challenges of insider research in educational institutions: Wielding a double-edged sword and resolving delicate dilemmas. *Oxford Review of Education*, 33(1), 1–17. <https://doi.org/10.1080/03054980601094651>
- Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.
- Mihret, G., & Joshi, J. S. (2025). The relationship between students' reading skill and academic achievement: A comprehensive investigation. *International Journal of Research Publication and Reviews*, 6(2), 2171–2181. <https://doi.org/10.55248/gengpi.6.0225.0913>
- Mikk, J. (2008). Sentence length for revealing the cognitive load reversal effect in text comprehension. *Educational Studies*, 34(2), 119–127. <https://doi.org/10.1080/03055690701811164>
- Ministry of Education. (2007). *The New Zealand curriculum*. Learning Media. <https://nzcurriculum.tki.org.nz/The-New-Zealand-Curriculum>
- Ministry of Education. (2018). *National Monitoring Study of Student Achievement: Science 2017*. University of Otago & NZCER. https://nmssaproductio.n.s3.amazonaws.com/documents/2017_NMSSA_SCIENCE.pdf
- Ministry of Education. (2020a). *Action Plan for Pacific Education 2020–2030*. Ministry of Education (NZ). <https://assets.education.govt.nz/public/Action-Plan-for-Pacific-Education-20202030.pdf>
- Ministry of Education. (2020b). *Ka Hikitia – Ka Hāpaitia: The Māori Education Strategy*. Ministry of Education (NZ). <https://www.education.govt.nz/our-work/strategies-policies-and-programmes/maori-education-and-language/ka-hikitia-ka-hapaitia>
- Moats, L. C. (1994). The missing foundation in teacher education: Knowledge of the structure of spoken and written language. *Annals of Dyslexia*, 44(1), 81–102. <https://doi.org/10.1007/BF02648156>
- Moats, L. C. (2005). How spelling supports reading. *American Educator*, 29(4), 12–22.
- Moats, L. C. (2020). *Speech to print: Language essentials for teachers* (3rd ed.). Paul H. Brookes.
- Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2023). *TIMSS 2023 International Results in Mathematics and Science*. TIMSS & PIRLS International Study Center, Boston College & IEA.
- Nagy, W. E., & Anderson, R. C. (1984). How many words are there in printed school English? *Reading Research Quarterly*, 19(3), 304–330. <https://doi.org/10.2307/747823>
- Nagy, W. E., Berninger, V. W., & Abbott, R. D. (2006). Contributions of morphology beyond phonology to literacy outcomes of upper-elementary and middle-school students. *Journal of Educational Psychology*, 98(1), 134–147. <https://doi.org/10.1037/0022-0663.98.1.134>
- Nagy, W. E., & Townsend, D. (2012). Words as tools: Learning academic vocabulary as language acquisition. *Reading Research Quarterly*, 47(1), 91–108. <https://doi.org/10.1002/RRQ.011>

- Nation, K. (2019). Children's reading difficulties, language, and reflections on the Simple View of Reading. *Australian Journal of Learning Difficulties*, 24(1), 47–73. <https://doi.org/10.1080/19404158.2019.1609272>
- Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, 87(2), 224–240. <https://doi.org/10.1002/sce.10066>
- Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, 16(1), 1–13. <https://doi.org/10.1177/1609406917733847>
- OECD. (2023a). *PISA 2022 Results (Volume I): The State of Learning Worldwide*. OECD Publishing. <https://doi.org/10.1787/53f23881-en>
- OECD. (2023b). *PISA 2022: Insights and Interpretations*. OECD Publishing. Retrieved from <https://www.oecd.org/pisa/2022-results/>
- OECD. (2023c). *PISA 2022 Results (Volume I & II): Country Note – New Zealand*. OECD Publishing. Retrieved from <https://www.oecd.org/pisa/New-Zealand-Note-2022.pdf>
- O'Reilly, T., & McNamara, D. S. (2007). The impact of science knowledge, reading skill, and reading strategy knowledge on more traditional “high-stakes” measures of high school students' science achievement. *American Educational Research Journal*, 44(1), 161–196. <https://doi.org/10.3102/0002831206298171>
- Oakhill, J., & Cain, K. (2012). The precursors of reading ability in young readers: Evidence from a four-year longitudinal study. *Scientific Studies of Reading*, 16(2), 91–121. <https://doi.org/10.1080/10888438.2010.529219>
- Paas, F., Renkl, A., & Sweller, J. (2004). Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science*, 32(1–2), 1–8. <https://doi.org/10.1023/B:TRUC.0000021806.17516.d0>
- Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), 533–544. <https://doi.org/10.1007/s10488-013-0528-y>
- Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). SAGE.
- Perfetti, C. A. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading*, 11(4), 357–383. <https://doi.org/10.1080/10888430701530730>
- Perfetti, C. A., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading*, 18(1), 22–37. <https://doi.org/10.1080/10888438.2013.827687>
- Rasinski, T. V., Padak, N., Newton, R. M., & Newton, E. (2011). *Vocabulary instruction: From academic research to classroom practice*. Routledge.
- Reed, D. K. (2008). A synthesis of morphology interventions and effects on reading outcomes for students in grades K–12. *Learning Disabilities Research & Practice*, 23(1), 36–49. <https://doi.org/10.1111/j.1540-5826.2007.00261.x>

- Schlepppegrell, M. J. (2004). *The language of schooling: A functional linguistics perspective*. Lawrence Erlbaum Associates Publishers.
- Schwandt, T. A. (2000). Three epistemological stances for qualitative inquiry: Interpretivism, hermeneutics, and social constructionism. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 189–213). SAGE.
- Sedita, J. (2024). *Disciplinary literacy: Why it matters and what we should do about it* (White paper). Keys to Literacy.
<https://keystoliteracy.com/wpcontent/uploads/2024/11/Disciplinary-Literacy-White-Paper.pdf>
- Shanahan, T., & Shanahan, C. (2008). Teaching disciplinary literacy to adolescents: Rethinking content area literacy. *Harvard Educational Review*, 78(1), 40–59.
<https://doi.org/10.17763/haer.78.1.v62444321p602101>
- Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition*, 55(2), 151–218. [https://doi.org/10.1016/0010-0277\(94\)00645-2](https://doi.org/10.1016/0010-0277(94)00645-2)
- Share, D. L. (2008). On the anglocentricities of current reading research and practice: The perils of overreliance on an “outlier” orthography. *Psychological Bulletin*, 134(4), 584–615. <https://doi.org/10.1037/0033-2909.134.4.584>
- Smith, L. T. (2012). *Decolonizing methodologies: Research and Indigenous peoples* (2nd ed.). Zed Books.
- Snow, C. E. (2010). Academic language and the challenge of reading for learning about science. *Science*, 328(5977), 450–452. <https://doi.org/10.1126/science.1182597>
- Snow, C. E., Porche, M. V., Tabors, P. O., & Harris, S. R. (2009). *Is literacy enough? Pathways to academic success for adolescents*. Harvard University Press.
- Snow, C. E., & Uccelli, P. (2009). *The challenge of academic language*. In D. R. Olson & N. Torrance (Eds.), *The Cambridge handbook of literacy* (pp. 112–133). Cambridge: Cambridge University Press.
- Stanford, J. (2025, May 15). *Raising achievement and closing the equity gap in schools* [Press release]. New Zealand Government.
<https://www.beehive.govt.nz/release/raising-achievement-closing-equity-gap-school>
- Stebbins, R. A. (2001). *Exploratory research in the social sciences*. SAGE.
<https://doi.org/10.4135/9781412984249>
- Strohmaier, A. R., Ehmke, T., Härtig, H., & Leiss, D. (2023). On the role of linguistic features for comprehension and learning from STEM texts: A meta-analysis. *Educational Research Review*, 39, 100533. <https://doi.org/10.1016/j.edurev.2023.100533>
- Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4
- Sweller, J. (2020). Cognitive load theory and educational technology. *Educational Technology Research and Development*, 68(1), 1–16.
<https://doi.org/10.1007/s11423-019-09701-3>

- Sweller, J. (2023). The development of cognitive load theory: Replication crises and incorporation of other theories can lead to theory expansion. *Educational Psychology Review*, 35, Article 95. <https://doi.org/10.1007/s10648-023-09817-2>
- Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory*. Springer. <https://doi.org/10.1007/978-1-4419-8126-4>
- Sweller, J., van Merriënboer, J. J. G., & Paas, F. (2019). Cognitive architecture and instructional design: 20 years later. *Educational Psychology Review*, 31(2), 261–292. <https://doi.org/10.1007/s10648-019-09465-5>
- Tenny, S., Brannan, J. M., Brannan, G. D., & Sharts-Hopko, N. C. (2022). Qualitative study. In *StatPearls*. StatPearls Publishing. <https://pubmed.ncbi.nlm.nih.gov/29262162/>
- Tunmer, W. E., & Greaney, K. T. (2010). Defining reading difficulties. In N. K. Duke & M. H. Mallette (Eds.), *Literacy research methodologies* (2nd ed., pp. 147–162). Guilford Press.
- Tunmer, W. E., & Hoover, W. A. (2019). The cognitive foundations of learning to read: A framework for preventing and remediating reading difficulties. *Australian Journal of Learning Difficulties*, 24(1), 75–93. <https://doi.org/10.1080/19404158.2019.1614081>
- Wellington, J., & Osborne, J. (2001). *Language and literacy in science education*. Open University Press.
- Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). SAGE.

Appendix One: Interview Guide

Introduction

- Provide a brief introduction of myself.
- Tell me a bit about yourself as a teacher.
- Tell me about how you teach science to students?
- From what you are saying, you view xxx to be very important to teach children about science?

Purpose of the Study

- I am really interested in the language of science. Tell me about how you teach the language of science.
- Thank you for agreeing to participate in this interview. My research focuses on how morphological awareness can support science vocabulary and comprehension for intermediate students.
- Your insights will help develop a deeper understanding of the role of morphology in learning science concepts.
- Something I have become really interested in is how we ensure that lower progress readers and writers access the language of science. Tell me what you may do for these learners.

Reminder of Confidentiality/Consent

- Your participation is voluntary, and you can withdraw at any time without consequences. If you would like your data withdrawn, you must do this within two weeks of your receipt of the transcript to review.
- The interview will be audio-recorded and later transcribed. All data will be anonymised.

- Do you still consent to participate and to have this interview recorded?

Topic One: Language of Science

Possible Interview Questions:

- How do you currently teach the language of science to ākongā?
- Tell me about a time when the teaching didn't go as expected. Why do you think that was?
- Tell me about a time when the teaching exceeded your expectations. Why do you think that was?
- How do you ensure that lower-progress readers and writers can access the language of science?
- Tell me about the strategies you use to help students understand complex words in science.
- Describe the challenges you face in teaching scientific language, and how you address them.
- Do you think reducing the mental effort involved in learning new words might help students better understand science concepts? Why/why not?
- Do you notice a connection between students' difficulties with vocabulary and their overall reading comprehension in science? Can you give an example?

Topic Two: Morphology

Introduce topic with this information:

Morphology is the study of the structure of words and how they are formed from smaller units of meaning called morphemes. For example, the word "photosynthesis" contains two morphemes: "photo" (meaning light) and "synthesis" (meaning putting together).

Possible Interview Questions:

- Do you think that simplifying words by breaking them into morphemes could help students feel less overwhelmed when reading science texts?
- Do you currently teach morphology as part of science vocabulary instruction? Why or why not?
 - Tell me about your experiences with teaching morphology as part of science vocabulary instruction.
 - In your opinion, do students seem to understand and remember science vocabulary better when they can break down words into smaller chunks
- What do you know about teaching morphology and where did you learn it?
- Can you describe how comfortable or prepared you feel when it comes to explicitly teaching morphology to help students decode complex science vocabulary?

Possible questions for teachers that do not teach morphology:

- Can you tell me a bit about why morphology hasn't been part of your science teaching so far?
- Are there particular barriers that make it difficult to include morphology? (e.g. time, resources, confidence/understanding)
- Even though you don't teach morphology explicitly, do you find that students struggle with complex science words? How do you help them with that?

- Have you ever broken down a science word—like 'photosynthesis' or 'geology'—with your class, even informally? Tell me about this.

Topic Three Morphology Programmes

- What instructional resources or tools would support your teaching of morphology in science?
- What would you need to know to help you feel confident using a morphology-based programme?
- How could a morphology programme be integrated into your existing curriculum without adding too much workload?
- Would you see this as more useful in pre-teaching, during content delivery, or as revision?
- What do you think about cross-curricular approaches?

General follow up prompts

- I would like you to tell me more about that.
- What did that make you think about?
- What did you do then?
- I would like to hear if you know of more examples of that.
- Could you walk me through that?

<p>Focused follow up prompts</p>
<ul style="list-style-type: none"> • What did that mean to you? • How did you feel about that? • What did you think was going on?
<p>Clarifying prompts</p>
<ul style="list-style-type: none"> • I am not sure if I understood you right. • Would you mind explaining that to me again so I can make sure I understand?

Closing Questions

- Is there anything else you would like to share about your experiences?

Final Remarks:

- Thank you for your time and valuable insights. If you'd like, I can share a summary of my findings with you once the study is complete.
- Would you be open to a follow-up discussion if needed?

Post-Interview Notes

- Immediate reflections on key information raised by the participant.
- Any observed non-verbal cues that may add context.
- Initial thoughts on themes emerging from the responses.