EDITED BY J. R. MARTIN, KARL MATON AND Y. J. DORAN

ACCESSING ACADEMIC DISCOURSE

Systemic Functional Linguistics and Legitimation Code Theory

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SEMANTIC WAVES

Context, complexity and academic discourse

Karl Maton

Introduction

Almost everyone in education shares a desire for knowledge that builds over time.[1] Scholars typically aim to generate ideas that retain value beyond the specificities of their original objects of study. Teachers wish their pedagogic practice to have effects beyond the initial conditions of learning so that students can build on previous understandings and transfer what they learn into future contexts. Policymakers proclaim that education must prepare students for living and working in fast-changing societies by providing the capacity to build knowledge throughout their lives. In short, cumulative knowledge-building in research, teaching and learning are at the heart of education. Conversely, debates over research and policy regularly express concern over what can be termed 'segmentalism' – when knowledge is so strongly tied to its context that it is only meaningful within that context. In research, segmentalism occurs where findings remain locked into an object of study and so fail to build knowledge; in teaching, segmentalism is where students learn highly segmented knowledges or skills. However, while almost everyone concerned with education shares the same desires, the question of how to actually achieve cumulative knowledge-building and avoid segmentalism is less clear.

This problem forms the starting point for a series of ongoing research projects bringing together Legitimation Code Theory (LCT) and systemic functional linguistics (SFL) to explore academic discourse. In this chapter I introduce some of the ideas from LCT being enacted in these projects and that have both provoked new SFL concepts that grapple with context and complexity (Chapters 4–5) and complemented SFL analyses into all manner of issues (e.g. Chapters 6–8). I begin by briefly highlighting key obstacles in education research to overcoming segmentalism: knowledge-blindness, which obscures the issue of knowledge-building itself, and typological theorizing, which cannot capture empirical practices nor embrace

change over time. In short, I argue that to understand the basis of knowledge-building we need to see the forms taken by knowledge practices in ways that are not themselves segmental, homogenizing and static.

Second, I introduce LCT as a means of conceptualizing knowledge practices that reveals their organizing principles, embraces diversity and allows us to see change over time. Specifically, I focus on concepts from the Semantics dimension, defining *semantic gravity* (exploring context-dependence) and *semantic density* (exploring complexity), and how they combine to conceptualize organizing principles underlying practices as *semantic codes*. Given the history of dialogue between SFL and the ideas of Basil Bernstein (see Chapter 1, this volume), I then briefly explicate how these concepts extend the framework inherited from Bernstein.

Third, I demonstrate how these LCT concepts are being used to explore the bases of knowledge-building and achievement in education, drawing on studies of student assessments and teaching practice. I illustrate how research is showing that high-achieving student work is typically characterized by *semantic waves* or recurrent shifts in context-dependence and complexity that weave together different forms of knowledge. This work is providing a basis for teaching more learners how to succeed at knowledge-building in their studies. I then reveal how semantic waves also offer a means for overcoming segmentalism in classrooms. Research shows that teaching practice is often characterized by a repeated pattern of unpacking abstract and complex academic discourse into context-dependent and simpler meanings. This raises the question of how this segmented knowledge can be transformed to become the relatively decontextualized and complex knowledge students must demonstrate in educational assessments to show their mastery of academic discourse. Using brief examples from History and Biology lessons I illustrate how semantic waves offer a potential means of traversing this gap in classroom practice. Lastly, I discuss the variety of forms taken by semantic waves and discuss how LCT concepts themselves enable the cumulative building of knowledge in research and practice.

Knowledge-blindness and segmental typologies

Knowledge-blindness

Much research into education is characterized by 'knowledge-blindness': knowledge as an object of study is obscured. This condition results at least partly from how psychology and sociology have influenced Anglophone educational research in recent decades (Maton 2014b: 3–8). On the one hand, psychologically-informed approaches typically construe 'knowledge' as mental processes and states of consciousness that reside within learners. 'Knowledge' is understood as ways of knowing. Accordingly, empirical research tends to explore how those ways of thinking change by studying generic processes of learning in which the nature of what is being learned is not a central concern. On the other hand, approaches informed by sociology and cultural studies typically construe 'knowledge' as reflecting power

relations among social categories of knowers (Maton and Moore 2010). The concern of research is to unmask the social power underpinning knowledge, to reveal the knowers whose interests it serves or diminishes, where the form taken by that knowledge is considered arbitrary.

Educational research has thus typically backgrounded knowledge as an object in favour of foregrounding the study of ways of knowing and knowers. What is being learned and how it shapes these processes of learning and power relations have been largely obscured. Such knowledge-blindness thus proceeds as if the nature of what is taught and learned has little relevance. Accordingly, debates over teaching have oscillated between pedagogies that are generalized across the curriculum, and knowledge-building has been typically understood generically, as accumulation of content or ill-defined skills such as 'critical thinking'. How the forms taken by academic discourse may enable or constrain cumulative teaching and learning remains relatively under-researched.

Segmental typologies

Highlighting knowledge-blindness is not to say there exist no models of knowledge. A host of thinkers, including Bourdieu, Foucault and Piaget, have distinguished everyday understandings from academic discourse and there exist numerous attempts to characterize different forms of academic discourse. For example, Biglan (1973a, 1973b) typologized disciplines into hard/soft, pure/applied, and life/non-life; Kolb (1981) offered categories of abstract/concrete and active/reflective; and Becher (1994) combined these typologies to describe the cultural and cognitive styles of researchers as disciplinary 'tribes'. Such distinctions are legion: context-independent/context-dependent; practical/theoretical; conceptual/contextual; declarative/procedural; knowledge about/knowledge of; and many more.

These models can begin to bring knowledge into view. However, in order to understand knowledge-building, one must not only see knowledge but also conceptualize changes in the forms taken by knowledge in ways amenable to empirical research. While overcoming knowledge-blindness, typologies of knowledge embody a second obstacle to doing so: segmental theorizing. Different typologies may expand or contract, overlap or integrate the types of knowledge they delineate, but nonetheless offer a series of strongly-bounded types into which relatively few empirical practices neatly fit and which struggle to capture change within or between types.

These problems are often mentioned when such models are proposed and debated. Proponents of a typology temper their advocacy by admitting, for example, that it 'cannot do justice to the complexity and variation of inquiry processes and knowledge structures in various disciplines' (Kolb 1981: 245). Critics of a typology focus on difficulties placing empirical practices into types, identify missing kinds of knowledge, and argue for further categories. Such caveats and criticisms highlight the problem but misunderstand its nature. The issue is not whether a typology offers sufficient categories to embrace the variegated and changing nature of knowledge

practices but rather that typologies cannot by themselves do so. Rather than a new typology, we need a different kind of model to augment typologies. This is soon evident to rigorous researchers: knowledge typologies make perfect sense until you attempt to analyze the real world. Usually examples offered by authors to illustrate types are sufficiently broad-brushed – often entire subject areas – to make intuitive sense. Accordingly, such typologies can be useful for thinking about knowledge practices in general. However, when engaged in analysis of complex, diverse and changing practices such as classroom pedagogy, these models prove impossible to enact. Rarely does empirical data fit neatly into the boxes of a typology – little in real-world contexts is clearly 'pure' or 'applied', 'hard' or 'soft', 'declarative' or 'procedural', and so on. Moreover, processes that unfold through time cannot be traced through typologies. Everything inside each type is homogenized and there is no way of accounting for processes of movement between types.

These limitations hold for Bernstein's model of 'discourses' and 'knowledge structures' (2000). As discussed in Chapter 1 (this volume), Bernstein's model inspired a renewed focus in SFL on knowledge in the early 2000s (Christie and Martin 2007; Christie and Maton 2011). However, problems arose when SFL scholars and educators attempted to enact the model to analyze and shape real-world practices. Few practices fitted into its dichotomies; most combined characteristics of 'hierarchical' and 'horizontal' knowledge structures; and change over time eluded the model. Bernstein himself highlighted that, at this stage of conceptual development, understanding of the principles underlying such dichotomous forms is 'very weak' in its 'generating power' (2000: 124). As I argue elsewhere (Maton 2013, 2014a, 2014b), Bernstein's approach suggests that the answer is not to abandon typologies but rather to additionally capture the organizing principles that generate the knowledge practices they delineate. Moreover, such concepts must enable research to determine difference, variation and similarity, and to explore change over time. This is an ongoing concern of LCT, to which I now turn.

Legitimation Code Theory: Semantics

Legitimation Code Theory is a sociological framework for researching and informing practice. Against knowledge-blindness, LCT construes knowledge as both socially produced and real, in the sense of having effects (Maton and Moore 2010), and so explores the effects of different forms taken by knowledge practices. Against segmental typologizing, LCT analyses these forms in terms of their underlying organizing principles. Chapter 2 (this volume) introduces how LCT construes practices as 'languages of legitimation' that embody 'messages' as to what should be legitimate, whose organizing principles are analyzed as 'legitimation codes'. The conceptual framework is structured into a series of 'dimensions' (or sets of concepts) that each explore a distinctive species of legitimation code. In this chapter I focus on the dimension of Semantics which conceives social fields of practice as *semantic structures* whose organizing principles are conceptualized as *semantic codes* that comprise *semantic gravity* and *semantic density*. I begin by defining these concepts.

Semantic gravity (SG) refers to the degree to which meaning relates to its context and may be stronger (+) or weaker (−) along a continuum of strengths. The stronger the semantic gravity (SG+), the more meaning is dependent on its context; the weaker the semantic gravity (SG−), the less meaning is dependent on its context. For example, the meaning of the name for a specific plant in Biology or a specific event in History embodies stronger semantic gravity than that for a species of plant or a kind of historical event, which in turn embodies stronger semantic gravity than processes such as photosynthesis or theories of historical causation. Semantic gravity thus traces a continuum of strengths with infinite capacity for gradation. One can also dynamize this continuum to analyze change over time in terms of: *weakening* semantic gravity (SG↓), such as moving from the local particulars of a specific case towards generalizations; and *strengthening* semantic gravity (SG↑), such as moving from generalized ideas towards concrete and delimited cases.

Semantic density (SD) refers to the degree of condensation of meaning within practices, whether symbols, terms, concepts, phrases, expressions, gestures, clothing, etc. Semantic density may be relatively stronger (+) or weaker (−) along a continuum of strengths. The stronger the semantic density (SD+), the more meanings are condensed within practices; the weaker the semantic density (SD−), the fewer meanings are condensed. Put another way, semantic density conceptualizes complexity: the stronger the semantic density, the more complex the practices. The strength of semantic density is not intrinsic to a practice but rather relates to the *semantic structure* within which it is located (and thus can change). For example, the term 'gold' commonly denotes a bright yellow, shiny and malleable metal used in coinage, jewellery, dentistry and electronics. However, within the discipline of Chemistry it is related to an atomic number, atomic weight, electron configuration and much more. Many of these meanings involve relations to other meanings as part of compositional structures, taxonomies and explanatory processes; for example, its atomic number represents the number of protons found in the nucleus of an atom, identifies it as a chemical element and situates it within the periodic table. Thus, 'gold' in Chemistry is located within a complex semantic structure that imbues the term with a greater range of epistemological meanings.[2] Another way of conceiving semantic density is in terms of 'relationality': the more relations established with other meanings, the stronger the semantic density (Maton and Doran 2017a, 2017b).

Semantic density traces a continuum of strengths, with infinite capacity for gradation. This continuum can be dynamized to describe *strengthening* semantic density (SD↑), such as moving from a term, symbol or practice condensing a small number of meanings towards one implicating a greater range of meanings. For example, bringing together places, periods, customs, beliefs, etc. as 'Mycenaean Greece' in History, or relating cell structures, proteins, pigments, etc. of a leaf to define 'photosynthesis' in Biology. Conversely, one can describe *weakening* semantic density (SD↓), such as moving from a highly condensed symbol to one involving fewer meanings. For example, unpacking technical concepts into simpler terms typically

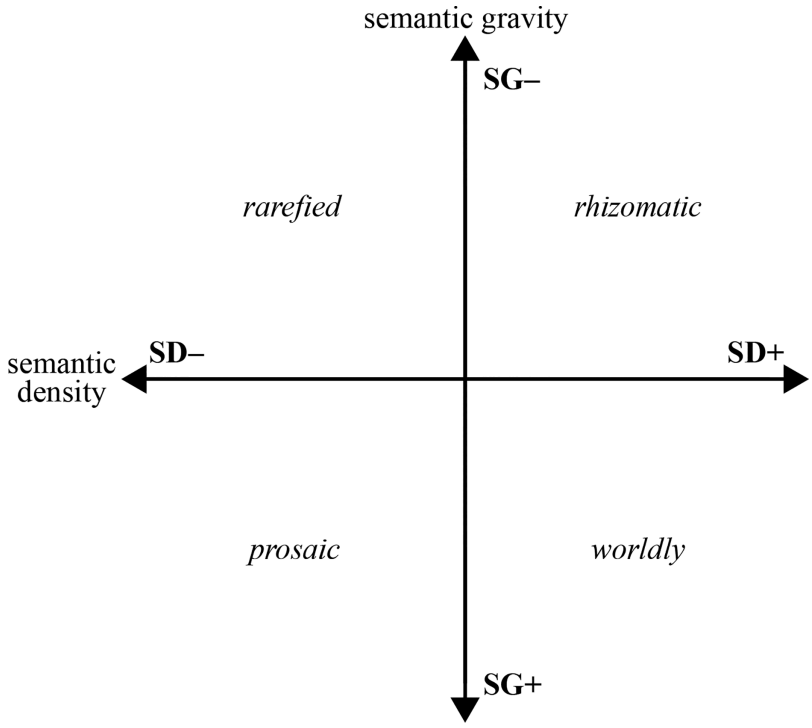

FIGURE 3.1 The semantic plane (Maton 2016: 16)

enacts a limited number of their meanings: the semantic density of the knowledge being expressed is weaker.

As will become clear, the examples given above for relative strengths of semantic gravity and semantic density are neither definitional nor definitive. The forms taken empirically by different strengths of semantic gravity and semantic density are different in each object of study and for each form of data. Accordingly, research develops 'translation devices' that translate between each of these concepts and different objects of study.[3] While these devices may involve types, 'semantic gravity' and 'semantic density' are not themselves types. *All* practices are characterized by *both* semantic gravity *and* semantic density; what differs are their strengths. These strengths may vary independently to generate *semantic codes* (SG+/−, SD+/−).

As shown in Figure 3.1, the continua of strengths of semantic gravity and semantic density can be visualized as axes of the *semantic plane* with four principal modalities:

- *rhizomatic codes* (SG−, SD+), where the basis of achievement comprises relatively context-independent and complex stances;
- *prosaic codes* (SG+, SD−), where legitimacy accrues to relatively context-dependent and simpler stances;

- *rarefied codes* (SG−, SD−), where legitimacy is based on relatively context-independent stances that are relatively simpler; and
- *worldly codes* (SG+, SD+), where legitimacy is accorded to relatively context-dependent stances that are relatively complex.

Beyond typologies: Semantic codes

Given the focus of this volume and the potential for confusion, it is worth emphasizing that the LCT dimension of Semantics is neither derived from nor directly related to 'discourse semantics' from SFL. Research may enact these two sets of concepts for complementary analyses (see Chapter 1, this volume), but they are from different frameworks. LCT concepts are entirely sociological. 'Semantic gravity' was first introduced at a Bernstein conference in 2007 and published in a collection of papers from that conference (Maton 2008, 2009); similarly, 'semantic density' was first presented at a Bernstein conference in 2008 and published in its accompanying collection (Maton 2011a).

As discussed in Maton (2009, 2011b, 2013), 'semantic gravity' and 'semantic density' originate from conceptualizing ideas left untheorized by Bernstein's framework in order to meet the demands of empirical research. Studies using other dimensions of LCT had been increasingly highlighting issues of context-dependence and complexity as significant for understanding their objects of study. Turning to Bernstein's theory for help revealed a need for conceptual development to address these issues. Context-dependence is tacit in his early work distinguishing 'elaborated codes', which 'orient their users towards universalistic meanings' and 'are less tied to a given or local structure', from 'restricted codes' that 'orientate, sensitize, their users to particularistic meanings' and 'are more tied to a local social structure' (1971: 176). Context-dependence also resurfaced obliquely in Bernstein's later distinction between segmented 'horizontal knowledge structures' and integrating, generalizing and abstracting 'hierarchical knowledge structures' (2000). Both models also hinted at the issue of condensation, albeit in different ways: the earlier distinction (1971) foregrounds 'condensed symbols' in terms of whether understandings are explicated or shared among actors and left unarticulated; and 'knowledge structures' (2000) raise questions of how ideas are interrelated in ways enabling more or less complexity of meaning.

Though touched upon by Bernstein's framework, the understanding of context-dependence and complexity remained at best tacit, entangled and descriptive. Theoretical development was needed to enable empirical research into real-world problems. Moreover, any newly developed concepts needed to be of a particular kind. Both Bernstein's early and later models offer dichotomous types (elaborated/restricted; hierarchical/horizontal). As noted earlier above, Bernstein described such types as 'very weak' in their 'generating power' (2000: 124). What was required was to explore the organizing principles underlying practices. That is what 'semantic gravity' and 'semantic density' have provided.

One example of the greater power these LCT concepts offer is their capacity to avoid a deep-seated dichotomy in educational thinking. Debates over

education have long been dominated by a recurring opposition between 'theoretical' and 'practical' forms of knowledge. These types are given a variety of names, including 'academic'/'everyday', 'uncommon sense'/'common sense', and 'vertical'/'horizontal'. The concepts of semantic codes reveal the false dichotomy underlying such models. These oppositions can be reconceptualized as representing *rhizomatic codes* (SG−, SD+) and *prosaic codes* (SG+, SD−), respectively. Put simply, each pair contrasts context-independent and complex knowledge practices with context-dependent and simpler knowledge practices. Using Figure 3.1, they only show the top-right and bottom-left quadrants of the plane. Crucially, this opposition excludes the possibility of the other quadrants: *rarefied codes* (SG−, SD−) that are context-independent but condense few meanings, such as jargon; and *worldly codes* (SG+, SD+) that are context-dependent but complex, such as professional and vocational knowledge. Semantic codes thereby allow us to see what has been hidden by dominant ways of thinking about education.

This may seem abstruse but limits on what Bourdieu (1991) called 'the space of possibles' can have serious real-world consequences. If public discourse does not distinguish between *rhizomatic codes* (SG−, SD+) and *rarefied codes* (SG−, SD−), in other words if the top half of Figure 3.1 is seen as all the same, ignoring differences in their complexity, then meaningful ideas (SD+) may become equated with meaningless claims (SD−), academic discourse (SD+) may be equated with jargon (SD−), and insight (SD+) and bullshit (SD−) viewed as equally valid. The presidential campaign of Trump and referendum campaign for Brexit offer salutory lessons here. Similarly, if *prosaic codes* (SG+, SD−) are the only form of context-dependent ideas, and so *worldly codes* (SG+, SD+) are obscured, then the possibility is denied of context-dependent practices being complex. This allows vocational education to be viewed as no more than everyday practices or as simplistic, 'dumbed-down' forms of academic discourse. Innumerable examples in public policy discourse in countries such as Australia demonstrate how the complexity (SD+) of vocational knowledge is frequently obscured.

Capturing change: Semantic profiles

Semantic codes go further than revealing additional kinds of knowledge practices – they offer a different means of theorizing that moves beyond the limitations of typologies. The semantic plane (Figure 3.1) represents a potentially infinite number of relational positions, avoiding homogenizing and strongly bounded categories. The concepts thus enable research to conceptualize differences and movements not only between but also within forms of knowledge practices. One can analyze strengthening and weakening of semantic gravity or semantic density (SG↑↓, SD↑↓) both between semantic codes (between quadrants of Figure 3.1) and within semantic codes (inside a quadrant of Figure 3.1).

This capacity to explore change is enhanced by tracing the strengths of semantic gravity and semantic density of practices over time to reveal a *semantic profile* and an associated *semantic range* between their highest and lowest strengths. Figure 3.2

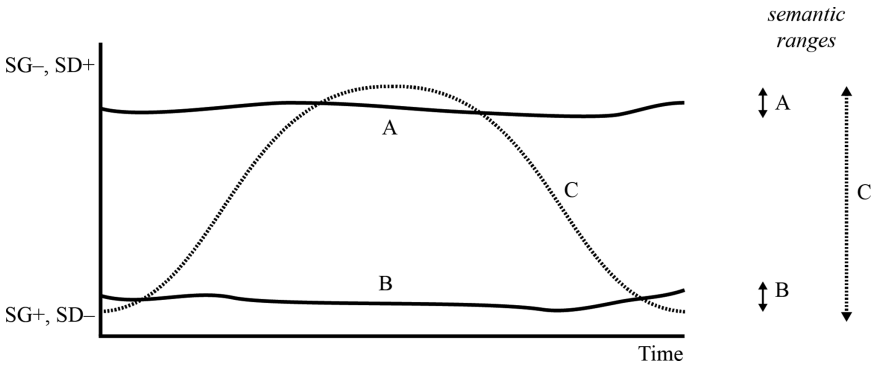

FIGURE 3.2 Three illustrative semantic profiles (Maton 2014b: 143)

portrays relative strengths on the *y*-axis, and time (such as the unfolding of classroom practice, curriculum or text) on the *x*-axis, and represents three illustrative profiles: a high *semantic flatline* (A), a low *semantic flatline* (B), and a *semantic wave* (C). Figure 3.2 also shows their respective *semantic ranges*: the flatlines 'A' and 'B' have much lower semantic ranges than the wave 'C'.

Semantic profiling can be as simple or as sophisticated as the problem demands. To introduce these ideas I shall present profiles that are relatively simple in two main ways. First, the profiles portrayed in this chapter combine semantic gravity and semantic density as a single line, with their strengths moving together inversely. This need not be the case: the two strengths may change independently and do not always move together. One may thus trace separate profiles for semantic gravity and semantic density. This reveals, among other things, where both are relatively strong or both are relatively weak, and so embraces all four semantic codes. Second, the profiles included here are intended to *heuristically* impart a sense of different kinds of movement between forms of knowledge. However, studies using these concepts are developing sophisticated instruments for calibrating profiles with precision. These 'translation devices' provide means of distinguishing different degrees of strength of semantic gravity and of semantic density (e.g. Maton and Doran 2017a, 2017b). Using these translation devices, profiles can be drawn with precision, down to the individual word, image, body movement or sound.

Nonetheless, the examples in this chapter offer a starting point for illustrating how semantic profiling reorients thinking about knowledge-building. By dynamizing analysis, it shifts the focus from types of knowledge to how knowledge changes over time. Crucially, it is also underpinning a growing body of studies into intellectual practices, curriculum, pedagogy and assessment. This has been a constant thread of concept development in LCT: concepts emerge from and for empirical research, and continue to evolve in close engagement with real-world data. Accordingly, I now illustrate their value through discussing examples from several research studies. For brevity, I confine my discussion to one conjecture emerging from research: the significance of 'semantic waves'.

Semantic waves in student work

A growing range of studies are exploring the bases of achievement in education by analysing the semantic profiles of student assessments. This research suggests that knowledge practices expressing *semantic waves* – recurrent strengthening and weakening of context-dependence and complexity – is rewarded across subject areas and levels of education as evidence of knowledge-building. For contrast, I shall briefly consider examples of the humanities in schooling and 'critical thinking' in higher education.

A compulsory unit of secondary school English for students taking the Higher School Certificate in New South Wales, Australia, requires students to explore abstract notions such as 'the journey' and 'belonging' in relation to diverse texts (Maton 2014b: 106–24). Between 2005 and 2008, students were asked to draw on three texts to answer the question: 'To what extent has studying the concept of imaginative journeys expanded your understanding of yourself, of individuals and of the world?' (Board of Studies 2006: 11). Figure 3.3 represents the semantic profiles of two essays. The high-achieving essay (the dashed line in Figure 3.3) was included in official syllabus documents as an exemplary model. This essay begins and ends by drawing on complex literary meanings (stronger semantic density) to bring together its examples in relation to a generalizing and abstract idea (weaker semantic gravity); for example, the essay begins:

> The journey, especially in the imaginative sense, is a process by which the traveller encounters a series of challenges, tangents and serendipitous discoveries to arrive finally, at a destination and/or transformation.
>
> *(Board of Studies 2006: 102)*

From this relatively high start, the essay moves down the semantic scale to describe simply the concrete particularities of each example, such as its author and main focus. It then quickly shifts upwards to more generalized and complex

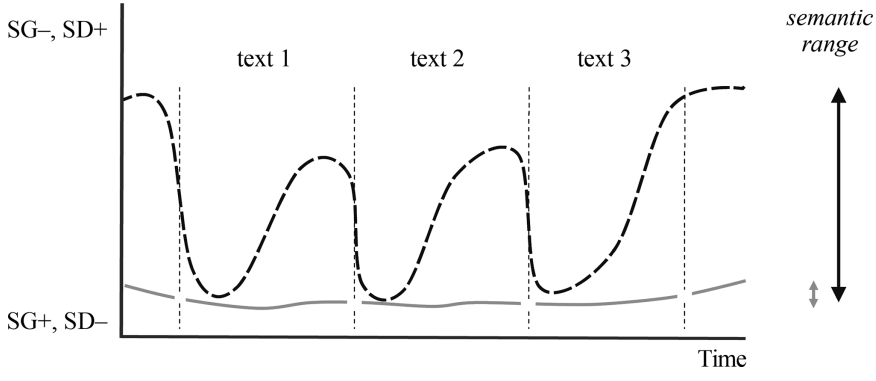

FIGURE 3.3 Semantic profiles of two student essays in school English

'literary' ideas, such as the notion of 'imaginative journeys'. For example, discussion of a text begins:

> *On Giants' Shoulders* depicts the individual lives and achievements of 12 scientists as a collective imaginative journey over the last 2,500 years. In portraying their separate profiles as one story in a chronological line up, Bragg delineates the concept of a cumulative and ongoing journey, reflected in his thesis that science is 'an extended kind of continuous investigation'.
>
> *(Board of Studies 2006: 103)*

This movement is repeated throughout the essay, tracing a series of semantic waves across its three texts (see Figure 3.3). The essay then ends even higher up the semantic scale by bringing together the more context-independent and complex meanings expressed in response to the three texts to express relatively context-independent and complex knowledge:

> I personally have learned the importance of individuals interlinking with others to achieve a greater end, and influencing or inspiring others, as inherent in the concept of scientists standing on 'giants' shoulders'.
>
> *(Board of Studies 2006: 103)*

In contrast, the low-achieving essay traces a relatively low semantic flatline.[4] Here the knowledge expressed comprises the student's immediate responses to a specific text in relation to his or her everyday life (stronger semantic gravity) and couched in non-technical, non-literary discourse (weaker semantic density). For example, discussing the novel *Ender's Game*, the student writes:

> It wasn't hard at all to imagine battle school as a real place because I was familiar with several scientific objects which surrounded us. For example, the 'Desk' sounds very familiar to a lap top computer.

The essay never moves away from expressing very concrete and simple meanings limited in space and time: it remains firmly rooted near the bottom of the semantic scale (see Figure 3.3). Even when concluding the essay, the essay does not integrate meanings; discussions of each of the three texts are kept separate: 'I took on three wonderful journeys'.

In summary, the low-achieving essay exhibits a low flatline, while the high-achieving essay traces a series of waves that weave together different forms of knowledge. The flatline embodies simpler knowledge that remains locked into the context of the individual student's personal response to a specific text at the time of reading. It does not connect with academic discourse, which would enable multiple relations with a complex constellation of meanings. It does not move beyond the limited context of a single reader with a single text. The resulting knowledge is thus highly segmental. As the broken line of Figure 3.3 depicts, there is no semantic flow

between discussions of texts. In contrast, the high-achieving essay involves building knowledge: the personal response of the student is connected to the complex constellations of academic discourse and developed into generalizations that reach beyond the limited context of the student reading a text at a particular moment in time. In short, achievement here involves demonstrating the capacity to build knowledge by connecting personal experience with academic discourse and moving beyond a specific context. This knowledge-building exhibits semantic waves.

Significantly, this profile resonates with findings of studies of other disciplines and levels of education. Szenes *et al.* (2015), for example, analyze 'critical reflection' assignments in Business and in Social Work at university. Figure 3.4 portrays an example of a high-achieving 'reflective journal' from a unit in Business. The journal comprises three principal stages. The first stage, in which the student discusses their beliefs and values ('Excavation' in Figure 3.4), is characterized by a rapid series of deep semantic waves as the journal shifts quickly between decontextualized, theoretical ideas of cultural values (such as 'individualism') and straightforward, concrete examples from the student's cultural context said to embody those values (such as the Australian cricketer Sir Donald Bradman). In the second stage, the student relates their own behaviour during teamwork with other students to these values ('Reflection' in Figure 3.4). Here semantic waves are milder: discussion of behaviour involves generalizations rather than descriptions of instances, and theoretical ideas are more context-dependent and simplified as their meanings are limited to those concerning the behaviour. In the final stage ('Transformation'), the student provides a list of generalized skills for successful participation in future teamwork situations that are claimed to embody the concept of 'intercultural competence', tracing a flatline midway between theory and empirical description.

Analysis of 'critical reflection' essays from Social Work highlight similarities and differences to the semantic profiles of Business. The profile of Figure 3.4 is repeated

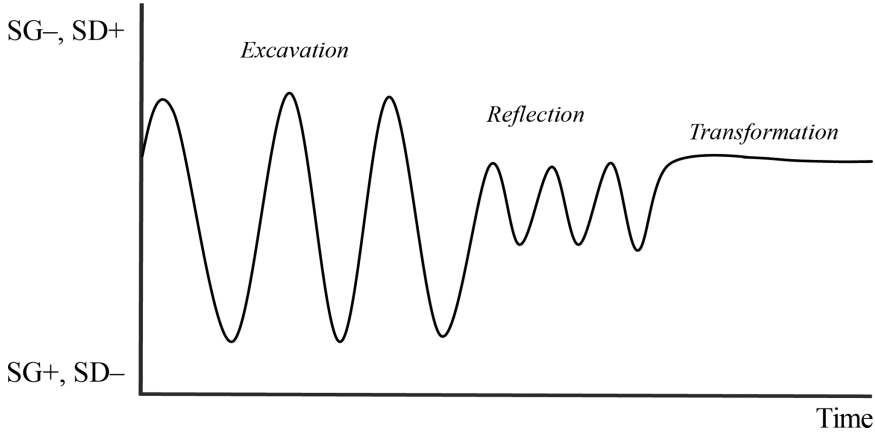

FIGURE 3.4 Semantic profile of a 'critical reflection' journal in undergraduate Business (adapted from Szenes *et al.* 2015)

in high-achieving Social Work essays but with an additional prior stage tracing a low flatline as students recount a 'critical incident' simply and concretely (Szenes *et al*. 2015). As Figures 3.3 and 3.4 suggest, the form taken by semantic waves can differ between subject areas (English/Business), kinds of assignment (essay/critical reflection journal) and level of education (school/university). I return to these differences, further below. Here, I shall highlight what is shared: semantic waves that weave together different forms of knowledge to demonstrate knowledge-building. This general finding is echoed in studies of curriculum, textbooks and student assessment across the disciplinary map, including Engineering (Wolff and Luckett 2013), English (Christie 2016), Design (Shay and Steyn 2016), History (Martin *et al*. 2010; Matruglio *et al*. 2013), Marketing (Arbee *et al*. 2014), and Physics (Georgiou 2016). Moreover, studies of intellectual practices are suggesting that semantic waves are also crucial to knowledge-building in research (Maton 2014b: 125–47; Hood 2016).

Semantic waves in classroom practice

While semantic waves may characterize achievement in education, the ability to wave is unevenly distributed across society. Major studies of student dispositions have yet to be conducted with semantic codes, but findings from research that used Bernstein's concepts are highly suggestive. For example, re-analysis of Holland's study of students (1981) suggests that students from social classes have different semantic coding orientations (Maton 2014b: 204–5). In other words, students come to education with dispositions that encompass different semantic ranges. Similarly, Hasan's major study of caregiver-child interactions (2009) highlights differences in the ability to move between concrete, simpler meanings and abstract, generalized and complex meanings. Among the questions such 'semantic variation' raises for education are whether classroom practices help model semantic waving and weaving to all students and, if not, how they can do so. These issues have been broached in major studies that bring together LCT and SFL as complementary frameworks to explore teaching and learning practices in History and Science lessons from all years of secondary schooling.[5]

One semantic profile we frequently found in these studies is depicted in Figure 3.5: a series of downshifts from context-independent and complex ideas (SG−, SD+) towards simpler and more concrete understandings, often including examples from everyday life (SG+, SD−). The practices associated with this profile typically involved teachers repeatedly unpacking and exemplifying meanings from written sources. For example, when reading together through a text or source, teachers often explained complex ideas and technical words to students using simpler, more everyday language and examples, and then returned to the text, finding more points to unpack and discuss. This traces a series of downshifts or 'down escalators'. However, rarely, if ever, did teachers move back up into academic discourse by repacking meanings and examples into more technical terms. Thus, teaching practice here models movements downwards but not back upwards from non-technicalized,

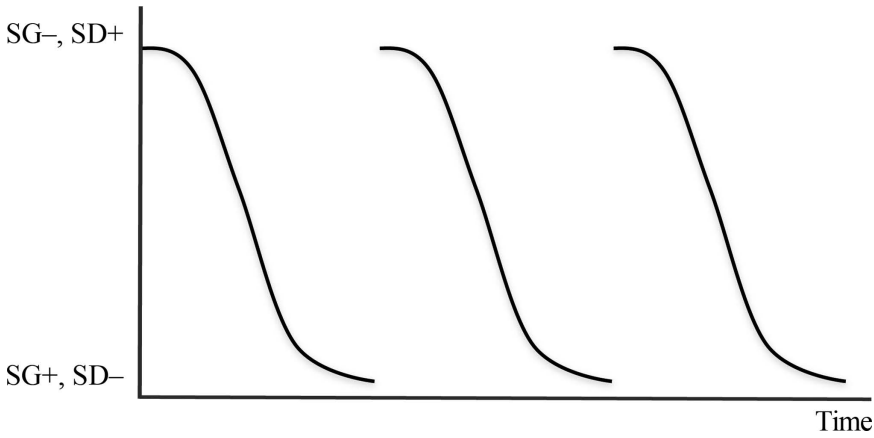

FIGURE 3.5 A 'down escalator' profile

concrete and often segmented knowledge towards more complex, technicalized knowledge that is plugged into the constellations of meanings constituting academic discourse. This represents a problem for overcoming segmentalism: knowledge characterized solely by stronger semantic gravity and weaker semantic density may be too tied to specific contexts and too disconnected from other meanings to either build upon previous knowledge or be built upon in the future.

This was not, however, the only semantic profile we discovered in classroom practice. Though less common, the study found teaching that also modelled upshifts and so created semantic waves in the academic discourse being expressed. Moreover, these semantic waves also model how meanings may be transformed through semantically weaving together different forms of knowledge. To illustrate these shifts I shall explicate a single semantic wave in two brief examples from Biology and History.[6]

Examples of semantic waves

The first example is from a Year 11 Biology classroom in which the topic of discussion is 'biological lines of defence', focusing on the 'cilia':

Teacher Okay [student name], what are the 'cilia'. What was it? No? [Student name] do you know what cilia is? No? Someone must know what they are . . .

Student Hairs

Student The little hairs?

Teacher The little hairs. And basically, they beat in an upward motion from inside your body out through to your nose. [Teacher waves arms upwards]. So, they beat up and they take the pathogens away with them. And, guys, I don't know if I've ever told you this, but when you smoke cigarettes,

> the tar actually causes your cilia to, because it's so heavy, to drop, and so your cilia don't work properly after that because they're too heavy, they've dropped, so they can't beat the pathogens out of your body! So that's one reason that smoking's bad as well. Okay! Alright, write this down under description!

Figure 3.6 portrays the semantic profile of this classroom interaction. It begins with the teacher introducing 'cilia', an abstract scientific term that condenses a wide range of meanings within Biology (see Martin 2013). The context of the Science classroom, the teacher's request for a definition, and the unfamiliarity of the word announce its relatively high position on the semantic scale ('*concept*' in Figure 3.6). With contributions from students, the teacher then unpacks some of the meanings condensed within the term using previously learned concepts ('pathogens'), everyday language ('the little hairs') and body language (waving her arms). With the effects of smoking, she also provides a concrete example from everyday life. Locating the 'cilia' in the body and setting limits to its functions strengthens semantic gravity; unpacking the term by outlining a small number of its meanings represents weaker semantic density. As shown by Figure 3.6 ('*unpacking*'), this moves the knowledge being expressed down the semantic scale towards more grounded and less complex meanings (SG+, SD−).

I should emphasize that to view the unpacking of academic discourse as weakening its semantic density is *not* to negatively evaluate such activity. Translating a technical term into common sense knowledge reduces its range of meanings, but that is the teacher's purpose here: to provide a point of entry for students into those complex meanings. This represents a potential starting point for the teacher and students to progressively strengthen its semantic density through elaborating, extending and refining additional meanings, such as locating the term within systems of composition, taxonomies and processes. The 'down escalator' profile discussed

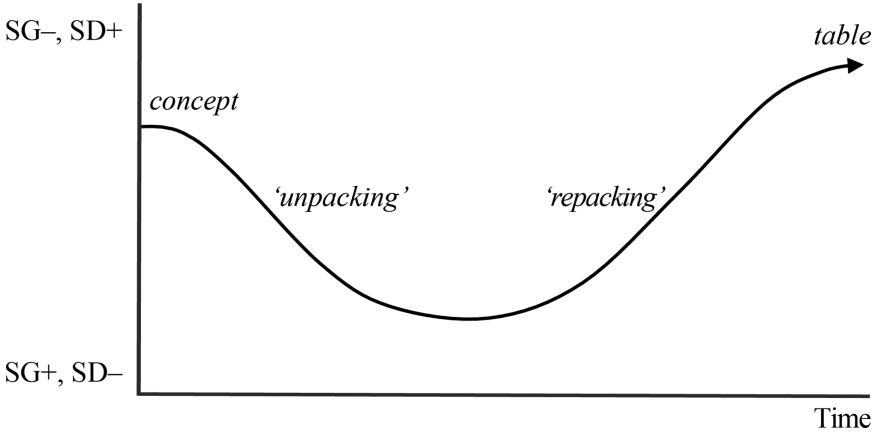

FIGURE 3.6 Example of a semantic wave in Biology teaching

TABLE 3.1 Example of a semantic wave in Biology teaching

cilia	Hair-like projections from cells lining the air passages	Move with a wavelike motion to move pathogens from the lungs until they can be swallowed into the acid of the stomach

earlier eschews this possibility by returning to the start of the sequence and commencing a new round of unpacking. However, in this example the teacher engages in 'repacking' knowledge into the term.

The excerpt ends with the teacher telling the students to 'write this down under description'. At this point the teacher writes on the board what is shown here as Table 3.1: 'cilia', a brief definition and a description of a function they serve in the body. This is more than a summary of the unpacking; it begins to repack the term 'cilia' by bringing together meanings without specific contexts such as smoking. In other words, it begins moving the knowledge being expressed back up the semantic scale – '*repacking*' in Figure 3.6. This achieves a semantic wave. Indeed, the upshift reaches beyond the level of the term 'cilia' because this definition forms part of a larger table (reproduced here as Table 3.2) that the teacher and students are working through together to learn about biological lines of defence. This table reveals a greater range of relations within which the term 'cilia' is embedded, including biological processes and causal explanations (for example, 'cilia' form part of the workings of 'chemical barriers'). Thus, in Figure 3.6 '*table*' is shown higher than '*concept*' because it embodies more generalized and complex knowledge. As the table shows, the semantic wave thus forms part of a longer sequence in which teaching and learning builds on previously discussed ideas that are also taken forward into the future.

It should be emphasized that the example from Biology is only one form of semantic wave. To illustrate this diversity, the second example is from a Year 11 History classroom in which a take-home assignment on 'the influence of Greek and Egyptian cultures in the Roman Empire' is being discussed. The question includes terms from the academic discourse of History characterized by weaker semantic gravity and stronger semantic density: 'Greek culture', 'Egyptian culture' and 'Roman Empire' embrace a range of meanings concerning time periods, locations, practices, beliefs, etc. Moreover, the question condenses more than the sum of its terms: explicating 'influence' requires understanding historical processes of causation. The knowledge evoked by the question thereby sits relatively high up the semantic scale.

The teacher begins the activity by highlighting the difficulty of the question, indicating the knowledge being discussed is relatively high on the semantic scale:

Teacher This is a little bit hard: 'The influence of Greek and Egyptian cultures.' What does that mean? What would the influence of Greek and Egyptian cultures mean, okay? No idea, right?

TABLE 3.2 Biology teacher's table entry for 'cilia'

Line of defence	*Description*	*What it does*
skin	Skin continuously grows by new cells being produced from below. Cells fit tightly together to form a protective layer covered by dead cells.	When unbroken skin prevents the entry of pathogens. Pores in the skin secrete substances that kill microbes. Skin constantly (lakes off carrying microbes away. It is a difficult environment for a pathogen to grow (no water).
mucous membrane	Cells lining the respiratory tract and openings of the urinary and reproductive systems that secrete a protective layer of mucous.	
cilia	Hair-like projections from cells lining the air passages	Move with a wavelike motion to move pathogens from the lungs until it can be swallowed into the acid of the stomach
chemical barriers	Acid in the stomach, alkali in the small intestine, the enzyme lysozyme in the tears.	Stomach acid destroys pathogens including those that are carried to the throat by cilia and then swallowed. Alkali destroys add resistant pathogens. Lysozyme dissolves the cell membranes of bacteria.
other body secretions	Secretions from sweat glads and oily secretions from glands in hair follicles.	Contain chemicals that destroy bacteria and fungi.

Figure 3.7 thus depicts the profile as beginning relatively high ('*question*'). The teacher then moves the knowledge being expressed down the semantic scale in stages ('*unpacking*' in Figure 3.7) by providing a series of examples of 'influence':

Teacher What it means is, if we started to look at all the things in Pompeii and Herculaneum, what objects may be showing Greek design? Or Egyptian design? Or Greek mythology? Or Egyptian mythology? Or what building techniques like columns? Are there Greek columns? Do, you know, are the themes of their artwork reflecting it?

With the examples of 'objects' that 'may be showing Greek design', 'Egyptian design', 'Greek mythology' and 'Egyptian mythology', the knowledge expressed

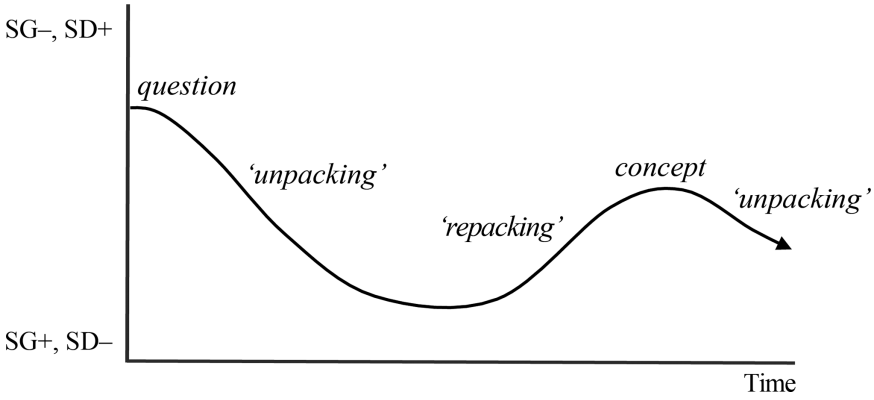

FIGURE 3.7 Example of a semantic wave in History teaching

by the teacher begins to move down the semantic scale by specifying and unpacking meanings from the wide-ranging, abstract terms of the question, a move continued by the more specific and concrete example of 'building techniques' and 'columns', which is in turn exemplified by 'Greek columns'. The teacher also grounds the question in the historical period (through examples of prior events in history) and the current discussion of the question in the context of previous lessons:

Teacher So, it's saying… remember when we started, we said that Pompeii had originally been settled by Greeks? Okay? And if we look at where Italy is, it's not that far from Egypt at this time, umm, we've, we've had, umm… Cleopatra has been killed by the time the volcano erupts, she and Mark Antony are dead and Egypt is part of the Roman Empire.

Thus far, the teacher has downshifted the knowledge being expressed. However, rather than return to the question and repeating this procedure (in the manner of 'down escalators'), she moves back up the semantic scale:

Teacher So there would be massive amounts of trade going on, and umm, you know people visiting their diplomats you know or their, their, ambassadors… like their envoys and things like that all going back and forth across the countries. So, ideas. When you get trade in ideas – you wouldn't have heard this word before – we call it 'aesthetic trade'. Have you heard of it? Yeah.
Student You told us before.
Teacher Ohh! Told you before great, *excellent*! You remember aesthetic trade!

This discussion weakens semantic gravity by discussing recurrent events (trade and diplomatic visits) rather than specific events, and strengthens semantic density

by 'packing up' various activities being conducted between countries into 'trade in ideas' and then into the technical term 'aesthetic trade' (see '*repacking*' to '*concept*' in Figure 3.7). Though this does not return to the heights embodied by the question, this upshift almost completes a semantic wave to explain one key aspect of 'influence'.

As with the Biology example, a semantic profile is typically part of a bigger picture, set within preceding and subsequent practices. In this example, the knowledge being expressed shifts down the scale again: the teacher provides examples of the concept of 'aesthetic trade' and emphasizes how 'hard' questions can be 'unpacked' in this way:

Teacher So that's what that one is. It looks hard, but all you've gotta do is have a look and think what things are there. Let me give you a big clue some of them are massive. [Teacher sings…] Laah-la-lah-la- la-la-la-la-lahh, la-lah

Student Theatres

Student La-lahh

Teacher Theatres. Okay, theatres are a Greek design. The Greeks invented the theatre, and then the Romans take the idea because they like it too. So, some of them are very obvious.

The teacher thus transforms academic discourse into everyday discourse and then back again, weaving together different forms of knowledge to explain a key aspect of the knowledge students are being asked for by the question. In particular, the passage illustrates how the teacher modelled not only downshifting but also upshifting from simpler, contextualized meanings towards more complex, decontextualized meanings.

Waves upon waves

Though specifying and 'unpacking', generalizing and 'repacking' may be valuable pedagogic strategies, the principal point of the preceding examples is not to identify exemplary practices. There are many other ways to move up and down the semantic scale. Rather, the point is to illustrate how the knowledge being expressed embodies semantic waves. While I have illustrated waves at a micro-level of short passages of practice, semantic profiles can be traced at any level: an individual exchange, a phase of activity, a lesson, a unit of study, a course, a subject curriculum, an entire educational career, and so on. Which level is useful for an analysis depends on the problem-situation. Bringing levels together may also help provide insights into knowledge-building: as one moves from micro through meso to macro levels, profiles may reveal waves within waves. For example, a recent major study is analyzing whole units of study – 4–6 hours of lesson time – in Science and History in Years 7, 8 and 9.[7] The preceding examples each lasted one or two minutes of lesson time; Figure 3.8 portrays the semantic profile of four lessons that total six hours of lesson

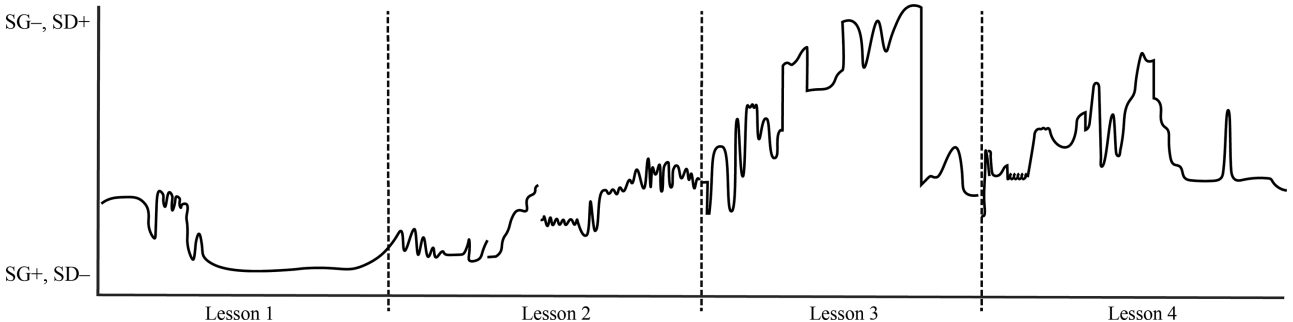

FIGURE 3.8 Profile of six hours of Year 7 Science lessons at Lauda School

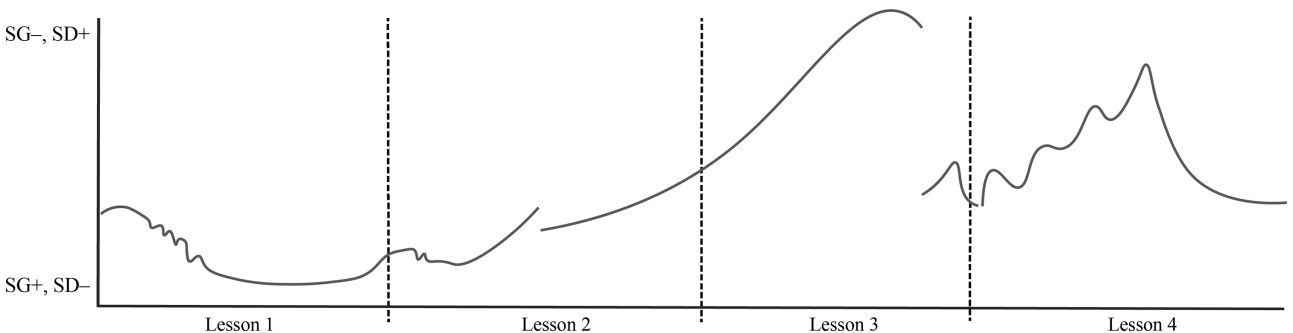

FIGURE 3.9 Trendline for Year 7 Lauda School Science lessons

time. This unit of study is from Year 7 Science, on the causes of Earth's seasons. We can also move between levels. One could zoom into a specific passage in Figure 3.8 and analyze semantic shifts in greater detail. This would reveal, for example, that the semantic waves generated by this teacher at the start of lesson 2 involves smaller waves as the knowledge being expressed moved upwards and downwards – waves within waves. Conversely, one could take a broader-brushed view: Figure 3.9 portrays the trend line for these lessons, revealing a giant cresting wave over the first three lessons, from which a new wave begins that builds on one aspect of the knowledge built up thus far. Space precludes discussing this analysis in greater detail here; the point is that micro-waves are not the only level of analysis for semantic profiling. One can also analyze macro-waves and relations between the different levels, to help reveal how clauses, phases, lessons and beyond each contribute to knowledge-building. Indeed, ongoing studies of longer timeframes are suggesting that overcoming segmentalism involves a fractal pattern of waves within waves (or waves upon waves).

Teaching semantic waves

If semantic waves are a key to knowledge-building and achievement in education, and if the ability to wave is not equally shared among learners of different backgrounds, then teaching students how to master semantic waves is an urgent task. Accordingly a growing number of educators are embedding these ideas into curriculum, pedagogy and assessment. Some examples of ongoing practice include:

- academic development programmes in numerous universities across South Africa and teacher training courses in Australia, Denmark and South Africa are empowering university lecturers and future schoolteachers, respectively, with LCT tools for shaping their curriculum design and teaching practice;
- individual teachers in subjects as diverse as chemistry, jazz music, engineering and ballet are using semantic waves to teach students how to succeed;
- a new engineering faculty created by private 'Multiversity' provider STADIO is being created that uses LCT to shape all aspects of practice, from curriculum to the building design;
- curriculum in subjects from a Diploma in Youth Work in Australia to English for Academic Purposes programmes in China are being structured to ensure knowledge is sequenced in waves that progressively extend the semantic range of students; and
- students in Australia, the UK, Poland, Mexico, the USA and many other countries are being taught to use semantic profiles to analyze what their assignments are asking and to support their writing.

Valuably, a growing number of these innovative practices are being written up for publication, enabling insights into how students can be supported to achieve semantic waves, including in History (Macnaught *et al.* 2013), Chemistry (Blackie

2014), Political Science (Clarence 2016), English for Academic Purposes (Kirk 2017), and Biology (Mouton and Archer 2019). These practices are revealing both the widespread applicability of semantic profiles for empowering teachers and students across the institutional and disciplinary maps of education and the manifold diversity of semantic waves. They are generating not one-size-fits-all pedagogies, but rather bespoke means for knowledge-building that attend to the specificities of the practices at hand. I now turn to consider this diversity.

Different semantic waves

Semantic waves can take many forms. As mentioned above, studies are revealing the diverse nature of semantic waves generated by a series of features, including range, directional shifts, entry and exit points, flow, and threshold.

First, in terms of *semantic range*, though the limited nature of flatlines may be problematic, it is not a simple case of 'the higher the better'. For example, research into undergraduate physics (Georgiou *et al.* 2014) reveals that students may reach too high up the semantic scale in their assessed work, using concepts, principles, equations or laws that are overly generalizing or which condense more meanings than appropriate to their assignment. This 'Icarus effect' suggests one facet of being inducted into a subject area is learning the semantic range appropriate to addressing different kinds of problem-situations.

Second, though both upward and downward shifts are required for cumulative knowledge-building, the directions of *semantic shifts* may play different roles across academic subjects. This chapter has emphasized the significance of upshifts for classroom practices because of their relative neglect. However, research into professional education (e.g. Shay and Steyn 2016) suggests that downshifts may be crucial in teaching and learning appropriate ways to select, recontextualize and enact abstract and complex knowledge within concrete and specific cases of professional practice. Where the key is application of knowledge in specific contexts, downshifting may be crucial.

Third, semantic waves do not always look like the examples discussed in this chapter (all of which started and ended high). They may begin and end at other points on the semantic scale. For example, starting from concrete and simpler meanings may offer students a more engaging way in and out of the central focus of an activity. Similarly, practically-oriented subjects, such as vocational education, often begin and end with concrete examples and simpler meanings, creating bell-shaped waves. Ongoing research is thus exploring the role of different *entry points* and *exit points* in research publications, lessons, student assignments, etc.

Fourth, while the classroom examples exhibited relatively strong *semantic flow* or connectedness between consecutive points, this is not always the case. Knowledge expressed in practices may involve disconnected shifts up and down, such as unexplained jumps between theories and data or concepts and examples, or minimally linked moves that create vertiginous shifts in the context-dependence and complexity of meanings. This can offer insights into, for example, problems experienced in

successfully integrating theory and examples by students in assignments, by teachers in their teaching practice, and by research in relating concepts to data.

Last, the *semantic threshold,* or extent to which accuracy matters, may vary. Ongoing research suggests that the degree of this threshold differs across subject areas and through stages of education. For example, the definition of the function of 'cilia' offered by the teacher earlier in this chapter is not entirely correct: it too closely relates the respiratory system to the gastro-intestinal system. At this stage of the curriculum, however, it is within the bounds of semantic threshold: too much accuracy, entailing considerably more knowledge, could become confusing for students at this point. Further research may show that such simplified definitions are later elaborated and clarified as students progress through the curriculum, raising the semantic threshold.

In addition, the nature of the threshold may change. This chapter has discussed only epistemic-semantic gravity and epistemic-semantic density, where the knowledge comprises formal definitions and empirical descriptions. Here, semantic threshold concerns epistemological accuracy. However, there are other forms, such as axiological-semantic gravity and axiological-semantic density based on affective, aesthetic, ethical, political or moral stances (Maton, 2014b: 153–70). In these cases, having the right political or moral attitude may be crucial. For example, in educational research the notion of 'student-centred learning' is condensed with political connotations (Maton 2014b: 148–70) and analyses of History lessons reveal the moral meanings condensed within such terms as 'colonialism', 'nationalism' and 'imperialism' (Martin *et al.* 2010). In effect, this is to bring together Semantics with Specialization (see Chapter 2, this volume): epistemological forms concern epistemic relations and axiological forms concern social relations. Space precludes discussing this issue further here; the point is that there are more forms that semantic profiles can take, not only in terms of their shape but also in terms of what kinds of knowledge are involved.

Conclusion

Almost everyone in education shares a desire for cumulative knowledge-building, but this requires tools that can explore the organizing principles of knowledge practices. This chapter has introduced and exemplified concepts from the LCT dimension of Semantics. It has only touched the surface of how Semantics can help access academic discourse: the dimension includes more concepts and they can be used in more ways than have been discussed here. However, it does illustrate how Semantics can shed light on cumulative knowledge-building. Specifically, the chapter focused on the conjecture that semantic waves represent a key to cumulative development by enabling the recontextualization of knowledge through time and space. This also highlights that what may be powerful is not one form of knowledge, such as 'theoretical' or 'practical' knowledge, but rather how different forms are related and changed. In short, power resides in *semantic waves* that *weave* together and transform knowledges.

I have, however, emphasized that there is much more to be discovered. As discussed earlier above, semantic waves may take many forms – more research is required into the specific semantic profiles of different subject areas and stages of curriculum. Moreover, the concept of semantic threshold offers the salutary lesson that semantic waves may be a necessary but not sufficient condition for success, that 'getting it right' (whether epistemologically or axiologically) may be crucial. This also highlights the significance of working with subject specialists, and that building knowledge requires mastering both its form and its content. It is why, for example, pedagogic interventions enacting LCT are conducted collaboratively with subject-specialist teachers (e.g. Macnaught *et al*. 2013). Other issues for research include exploring the semantic codes of actors. As shown by the essays discussed earlier above, not all students recognize that semantic waves are a crucial aspect of assignments and/or realize such a profile in their written assessments. More generally, not everyone is equally capable of enacting the semantic codes required for achievement. As illustrated in Chapter 2 of this volume, practice is the meeting of two sets of codes: those defining the context and those characterizing actors' dispositions. More research is required into coding the dispositions that students bring to contexts by virtue of their past experiences, to reveal who is predisposed to succeed or fail and to suggest ways forward to achieve greater social justice in education. Different groups of knowers may require different ways of teaching them how to achieve the semantic profiles necessary for success.

Our understanding of semantic profiles is still at an early stage. However, this is not the final chapter: it develops ideas for further development; it contributes to a wider work-in-progress by a diverse range of scholars in LCT. Moreover, as this body of work is showing, the ideas outlined here provide a basis for exploring these issues further. Turning the tools of Semantics upon themselves helps explain this productivity: the concepts embrace an extensive semantic range, from abstract, generalizing, highly condensed and complex meanings as part of the wider sociological framework of LCT, to concrete, specific and simpler meanings in practical applications. As a growing number of studies illustrate, they can be enacted within research into a wide array of problem-situations. The concepts thereby enable analyses of an expanding range of apparently different phenomena to be brought together, highlighting their underlying uniformities and differences. As a whole, research practice in LCT thus itself embodies semantic waves to build knowledge about knowledge-building.

Notes

1 This paper builds on ideas presented in Maton (2013, 2014a).

2 There is more than one kind of semantic density. Here (and throughout this chapter) I discuss *epistemic–semantic density* based on the *epistemological condensation* of formal definitions and empirical descriptions (Maton and Doran 2017a, 2017b). It is worth noting that practices with weaker epistemic-semantic density may exhibit stronger *axiological-semantic density* based on *axiological condensation* of affective, aesthetic, ethical, political or moral stances (Maton 2014b: 153–70). In other words, this is not a deficit model of, for example, everyday understandings.

3 See Maton and Chen (2016) on how to develop 'specific translation devices' for a particular study; Chapter 2 (this volume) offers an example of a specific translation device for specialization codes; and Maton and Doran (2017a, 2017b) offer examples of 'generic translation devices' (capturing very general phenomena) for relating 'epistemic-semantic density' to English discourse.
4 This essay was collected for a major study discussed in Christie and Derewianka (2010).
5 Two major studies are the 'DISKS' project and the 'PEAK' project (see further below).
6 I draw here from the 'DISKS' project – Australian Research Council Discovery Project, DP0988123, Chief Investigators: Peter Freebody. J. R. Martin and Karl Maton.
7 I draw here on analyses from the 'PEAK' project – Australian Research Council Discovery Project, DP130100481, Chief Investigators: Karl Maton, J. R. Martin, Len Unsworth and Sarah K. Howard.

References

Arbee, A., Hugo, W. and Thomson, C. (2014) 'Epistemological access in Marketing – a demonstration of the use of Legitimation Code Theory in higher education', *Journal of Education*, 59: 39–63.

Becher, T. (1994) 'The significance of disciplinary differences', *Studies in Higher Education*, 19(2): 151–61.

Bernstein, B. (1971) *Class, Codes and Control* (Vol. I), London: Routledge & Kegan Paul.

Bernstein, B. (2000) *Pedagogy, Symbolic Control and Identity: Theory, research, critique* (revised edition), Oxford: Rowman & Littlefield.

Biglan, A. (1973a) 'The characteristics of subject matter in different academic areas', *Journal of Applied Psychology*, 53(3): 195–203.

Biglan, A. (1973b) 'Relationships between subject matter characteristics and the structure and output of university departments', *Journal of Applied Psychology*, 53(3): 204–13.

Blackie, M. (2014) 'Creating semantic waves: Using Legitimation Code Theory as a tool to aid the teaching of chemistry', *Chemistry Education Research and Practice*, 15: 462–9.

Board of Studies, New South Wales (2006) *Higher School Certificate Examination 2005, English, Paper 1 – Area of Study: Student answers*, Sydney: Board of Studies.

Bourdieu, P. (1991) 'The peculiar history of scientific reason', *Sociological Forum*, 6(1): 3–26.

Christie, F. (2016) 'Secondary school English literary studies: Cultivating a knower code', in K. Maton, S. Hood and S. Shay (eds) *Knowledge-building: Educational studies in Legitimation Code Theory*, London: Routledge, 158–75.

Christie, F. and Derewianka, B. (2010) *School Discourse: Learning to write across the years of schooling*, London: Continuum.

Christie, F. and Martin, J. R. (2007) (eds) *Language, Knowledge and Pedagogy: Functional linguistic and sociological perspectives*, London: Continuum.

Christie, F. and Maton, K. (2011) (eds) *Disciplinarity: Functional linguistic and sociological perspectives*, London: Continuum.

Clarence, S. (2016) 'Exploring the nature of disciplinary teaching and learning using Legitimation Code Theory Semantics', *Teaching in Higher Education*, 21(2): 123–37.

Georgiou, H. (2016) 'Putting physics knowledge in the hot seat: The semantics of student understandings of thermodynamics', in K. Maton, S. Hood and S. Shay (eds) *Knowledge-building: Educational studies in Legitimation Code Theory*, London: Routledge, 176–92.

Georgiou, H., Maton, K. and Sharma, M. (2014) 'Recovering knowledge for physics education research: Exploring the "Icarus effect" in student work', *Canadian Journal of Science, Mathematics, and Technology Education*, 14(3): 252–68.

Hasan, R. (2009) *Semantic Variation: Meaning in society and in sociolinguistics*, London: Equinox.
Holland, J. (1981) 'Social class and changes in the orientations to meanings', *Sociology*, 15(1): 1–18.
Hood, S. (2016) 'Ethnographies on the move, stories on the rise: Methods in the humanities', in K. Maton, S. Hood and S. Shay (eds) *Knowledge-building: Educational studies in Legitimation Code Theory*, London: Routledge, 117–37.
Kirk, S. (2017) 'Waves of reflection: Seeing knowledge(s) in academic writing', in J. Kemp (ed.) *EAP in a Rapidly Changing Landscape*, Reading: Garnet.
Kolb, D. A. (1981) 'Learning styles and disciplinary differences', in A. Chickering (ed.) *The Modern American College*, San Francisco: Jossey-Bass, 232–55.
Macnaught, L., Maton, K., Martin, J. R. and Matruglio, E. (2013) 'Jointly constructing semantic waves: Implications for teacher training', *Linguistics and Education*, 24(1): 50–63.
Martin, J. R. (2013) 'Embedded literacy: Knowledge as meaning', *Linguistics and Education*, 24(1): 23–37.
Martin, J. R., Maton, K. and Matruglio, E. (2010) 'Historical cosmologies: Epistemology and axiology in Australian secondary school history discourse', *Revista Signos*, 43(74): 433–63.
Maton, K. (2008) 'Gravité sémantique et Apprentissage segmenté', in P. Vitale and D. Frandji (eds) *Enjeux Sociaux, Savoirs, Langage, Pedagogie*, Rennes: University of Rennes Press, 151–68.
Maton, K. (2009) 'Cumulative and segmented learning: Exploring the role of curriculum structures in knowledge-building', *British Journal of Sociology of Education*, 30(1): 43–57.
Maton, K. (2011a) 'Knowledge-building: Analysing the cumulative development of ideas', in G. Ivinson, B. Davies and J. Fitz (eds) *Knowledge and Identity*, London: Routledge, 23–38.
Maton, K. (2011b) 'Theories and things: The semantics of disciplinarity', in F. Christie and K. Maton (eds) *Disciplinarity: Functional linguistic and sociological perspectives*, London: Continuum, 62–84.
Maton, K. (2013) 'Making semantic waves: A key to cumulative knowledge-building', *Linguistics and Education*, 24(1): 8–22.
Maton, K. (2014a) 'Building powerful knowledge: The significance of semantic waves', in B. Barrett and E. Rata (eds) *Knowledge and the Future of the Curriculum: International studies in social realism*, London: Palgrave Macmillan, 181–97.
Maton, K. (2014b) *Knowledge and Knowers: Towards a realist sociology of education*, London: Routledge.
Maton, K. and Chen, R. T.-H. (2016) 'LCT in qualitative research: Creating a translation device for studying constructivist pedagogy', in K. Maton, S. Hood and S. Shay (eds) *Knowledge-building: Educational studies in Legitimation Code Theory*, London: Routledge, 27–48.
Maton, K. and Doran, Y. J. (2017a) 'Semantic density: A translation device for revealing complexity of knowledge practices in discourse, part 1 – wording', *Onomázein Special Issue*, March: 46–76.
Maton, K. and Doran, Y. J. (2017b) 'Condensation: A translation device for revealing complexity of knowledge practices in discourse, part 2 – clausing and sequencing', *Onomázein Special Issue*, March: 77–110.
Maton, K. and Moore, R. (2010) (eds) *Social Realism, Knowledge and the Sociology of Education: Coalitions of the mind*, London: Continuum.
Matruglio, E., Maton, K., and Martin, J. R. (2013) 'Time travel: The role of temporality in enabling semantic waves in secondary school teaching', *Linguistics and Education*, 24(1): 38–49.

Mouton, M. and Archer, E. (2019) 'Legitimation code theory to facilitate transition from high school to first-year biology', *Journal of Biological Education*, 53(1): 2–20.

Shay, S. and Steyn, D. (2016) 'Enabling knowledge progression in vocational curricula: Design as a case study', in K. Maton, S. Hood and S. Shay (eds) *Knowledge-building: Educational studies in Legitimation Code Theory*, London: Routledge, 136–57.

Szenes, E., Tilakaratna, N. and Maton, K. (2015) 'The knowledge practices of critical thinking', in M. Davies and R. Barnett (eds) *The Palgrave Handbook of Critical Thinking in Higher Education*, London: Palgrave Macmillan, 573–91.

Wolff, K. and Luckett, K. (2013) 'Integrating multidisciplinary engineering knowledge', *Teaching in Higher Education*, 18(1): 78–92.