

Systemic Functional Linguistics and Legitimation Code Theory on Education: Rethinking field and knowledge structure

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Abstract

This paper presents an introduction to how systemic functional linguistics (SFL) and Legitimation Code Theory (LCT) offer complementary insights into education, focusing on key ideas that brought the theories into dialogue over the past decade. It begins with a review of SFL work on field, which foregrounds the role of forms of knowledge in education. It then discusses how SFL scholars engaged with and understood Bernstein's notions of 'knowledge structures' for modelling intellectual fields. This engagement raised a series of questions that were a basis for dialogue with LCT, which extends and integrates Bernstein's framework. The paper introduces key concepts from two dimensions of LCT —Specialization and Semantics— enacted in papers in this special issue. It then briefly summarizes two major research projects into education that enact these concepts alongside SFL and provide a context to the papers of this special issue, before introducing how these papers illustrate the growing and fruitful transdisciplinary dialogue between SFL and LCT.

Keywords:field; knowledge structure; SFL; Legitimation Code Theory.

1. Dialogue

In 2002 Geoff Williams invited the English sociologist Karl Maton to deliver a plenary address at the annual conference of the Australian Systemic Functional Linguistics Association. This was the occasion on which many Australian systemicists first encountered Maton's work. They were excited to learn that ideas of the late Basil Bernstein that had inspired educational research using systemic functional linguistics (SFL) were being extended. Of particular interest at this time were developments of Bernstein's concept (2000) of 'knowledge structures' by Maton (2000) and fellow sociologists such as Rob Moore (2000) and Johan Muller (2000), a loose school of thought known as 'social realism' (Maton & Moore, 2010). Inspired by this work, Frances Christie and Jim Martin fostered dialogue by organising an interdisciplinary conference in Sydney in 2004 (see Christie & Martin, 2007). This dialogue was continued by a second Sydney conference in 2008, organized by Frances Christie and Karl Maton (see Christie & Maton, 2011). Much has happened since Maton's plenary in 2002. Maton's ideas have become a fully-fledged conceptual framework (Maton, 2014b), called Legitimation Code Theory (LCT), which is now being widely used in sociology, education and linguistics. In the mid-2000s Maton's migration to Australia intensified dialogue between the approaches by bringing him into direct relations with the 'Sydney School' of SFL. There is now a large and thriving community of scholars and students enacting LCT and SFL together to study education and other social contexts (see Maton & Doran, forthcoming; Maton et al., 2016a). In 2015 these exchanges were further developed at the *International Systemic Functional Congress* held at the National University of Cuyo in Mendoza, Argentina, through keynote addresses, presentations and intensive courses. The papers presented in this special issue of *Onomázein* directly build on this initiative to both introduce SFL-LCT dialogue to scholars in Latin America (and elsewhere) and invite their participation in this exciting transdisciplinary conversation. Since then, even further developments: in 2016 the University of Sydney created the LCT Centre for Knowledge-Building under the Directorship of Karl Maton, with J. R. Martin as Deputy Director, which supported this special issue. SFL and LCT are working evermore closer together.

In this brief introduction to SFL and LCT we review some of the strands of work which provide foundations for this dialogue and comment on current research. There is a lot more to this dialogue than can be introduced here. LCT and SFL are proving particularly productive at challenging beliefs and provoking new ideas in one another. Nonetheless, we hope this introduction will provide insight into some of the issues that are bringing these complementary approaches together. We begin in section 2 by reviewing SFL work on the linguistic concept of field before discussing in section 3 how this work brought educational researchers in SFL into engagement with Bernstein's model of 'knowledge structures' during the early- to mid-2000s. We show how this engagement raised questions that generate the ongoing dialogue with LCT, a framework that extends Bernstein's concepts. In section 4 we introduce LCT, focusing on two dimensions particularly involved in dialogue with SFL —Specialization and Seman-

tics— and discuss how these concepts resolve problems raised by systemic linguists with the notion of ‘knowledge structures’. In section 5, we briefly discuss two recent transdisciplinary projects that illustrate how SFL and LCT are being enacted together to explore education and which provide a context to the papers collected in this special issue.

2. Field (SFL)

The strand of SFL research that particularly attracted systemicists to social realist sociology such as LCT was work developing the register variable field. This line of work emerged as part of the literacy focused action research associated with the ‘Sydney School’, as documented in Rose & Martin (2012); see also de Silva Joyce & Feez (2012), Derewianka & Jones (2012), de Oliveira & Iddings (2014) and Brisk (2015). The basic challenge here concerned moving on from a mastery of genres and their staging in primary school to developing genres which played their part in building the uncommon sense knowledge of secondary school. For this, a focus on field and mode, alongside genre, was crucial. Initial work on physical geography (Wignell et al., 1989) and history (Eggins et al., 1993) was supplemented with work on a range of secondary school and workplace fields—for key documentation, see Rose et al. (1992), Halliday & Martin (1993), Iedema et al. (1994), Iedema (1995), Christie & Martin (1997), Martin & Veel (1998), Coffin (2006), Wignell (2007) and Martin (2012). Most of this research was based on a collaboration between the Department of Linguistics at the University of Sydney and the Metropolitan East Region’s Disadvantaged Schools Programme, in the ‘Language and Social Power’ and ‘Write it Right’ projects (discussed in Rose & Martin, 2012, and Veel, 2006). By the mid-1990s federal funding for such programmes was diverted away from regional centres by state departments of education and redistributed to individual schools. This led to a hiatus in this trajectory of educational linguistic research.

The model of field being developed in this work was inspired by Halliday’s work on the language of science (Halliday, 2004) and drew heavily on Martin’s conception of field (1992) as a set of activity sequences oriented to some global institutional purpose, alongside the taxonomies of entities (people, places and things, both abstract and concrete) participating in these activities (organized by both classification and composition). The linguists involved were especially interested in how everyday sequences and taxonomies (Bernstein’s ‘common sense’) differed from the academic ones (Bernstein’s ‘uncommon sense’) challenging students across subject areas in secondary school. Particular attention was paid to the phenomenon of technicality whereby everyday or less specialized meanings were distilled as more specialized ones and used to build the uncommon sense taxonomies and implication sequences of humanities, social science and natural science disciplines. This process, of course, flagged the critical role played by grammatical metaphor in academic discourse (Halliday, 1998; Martin, 1993), both in definitions and explanations and in the composition of disciplinary genres. This

brought the register variable mode into the picture, since abstraction was a critical resource affording technicality, cause/effect relations inside the clause and evaluation. For overviews of this work, see Martin (2007a, 2007b).

Martin (2007a) draws on meteorology to introduce the model of field in play here, drawing on information provided by the Australian Government's Bureau of Meteorology website¹. As far as sequencing is concerned, they offer the follow explanation of cloud formation:

[1] Clouds have their origins in the water that covers 70 per cent of the earth's surface. Millions of tons of water vapour are evaporated into the air daily from oceans, lakes and rivers, and by transpiration from trees, crops and other plant life.

As this moist air rises it encounters lower pressures, expands as a result, and in doing so becomes cooler. As the air cools it can hold less water vapour and eventually will become saturated. It is from this point that some of the water vapour will condense into tiny water droplets to form cloud (about one million cloud droplets are contained in one rain-drop). Thus, whenever clouds appear they provide visual evidence of the presence of water in the atmosphere.

This uncommon sense implication sequence gives a simple explanation of how clouds form, working through a set of logically connected steps: water evaporates from bodies of water and transpires from plant life, and if it does so and rises, then it encounters lower pressures, and if it does, then it expands, and if it does, it becomes cooler, and if it does, it becomes saturated, and if it does, then some water vapour will condense into tiny water droplets (and so we see clouds). Such a sequence typifies uncommon sense ones—you cannot often see them happening (it takes too long, our eyes are not sharp enough and we rarely have a suitable vantage point), they are generalized (happening over and over again) and their steps are logically contingent (if one step happens another must follow).

Beyond uncommon sense sequencing, the entity emerging from this process (i.e. clouds) enters into uncommon sense taxonomies of both classification and composition. The following report introduces their classification into 27 subtypes and the criteria through which they are classified (their elevation):

[2] There are ten main cloud types, which are further divided into 27 sub-types according to their height shape, colour and associated weather. Clouds are categorized as low (from the earth's surface to 2.5 km), middle (2.5 to 6 km), or high (above 6 km). They are given Latin names which describe their characteristics, e.g. cirrus (a hair), cumulus (a heap), stratus (a layer) and nimbus (rain-bearing). It's an interesting fact that all clouds are white, but when viewed from the ground some appear grey or dark grey according to their depth and shading from higher cloud.

1 See <http://www.bom.gov.au/info/clouds/>.

The main groups and subtypes construed in this classifying report are outlined below; in addition there is a vertically developed cloud type which has one end on a high level and the other on a low level.

- 1 High-level clouds
 - 1.1 Cirrus
 - 1.2 Cirrocumulus
 - 1.3 Cirrostratus
 - 1.4 Contrail
- 2 Medium-level clouds
 - 2.1 Altostratus...
 - 2.2 Altocumulus
 - 2.3 Nimbostratus
- 3 Low-level clouds
 - 3.1 Stratocumulus
 - 3.2 Stratus
 - 3.3 Cumulus

Each of these subtypes can be further divided; a subclassification for altostratus clouds is listed below, based largely on what is considered significant about their appearance (as it reflects their origins and precipitation potential)². They are usually formed as air rises due to a weather front activity sequence.

altostratus duplicatus
 altostratus lenticularis
 altostratus mammatus
 altostratus opacus
 altostratus pannus
 altostratus praecipitatio
 altostratus radiatus
 altostratus translucidus
 altostratus undulatus
 altostratus virga

This kind of classification typifies uncommon sense taxonomies. The criteria on which the classification is based (here precise measures of elevation based on instrumental readings)

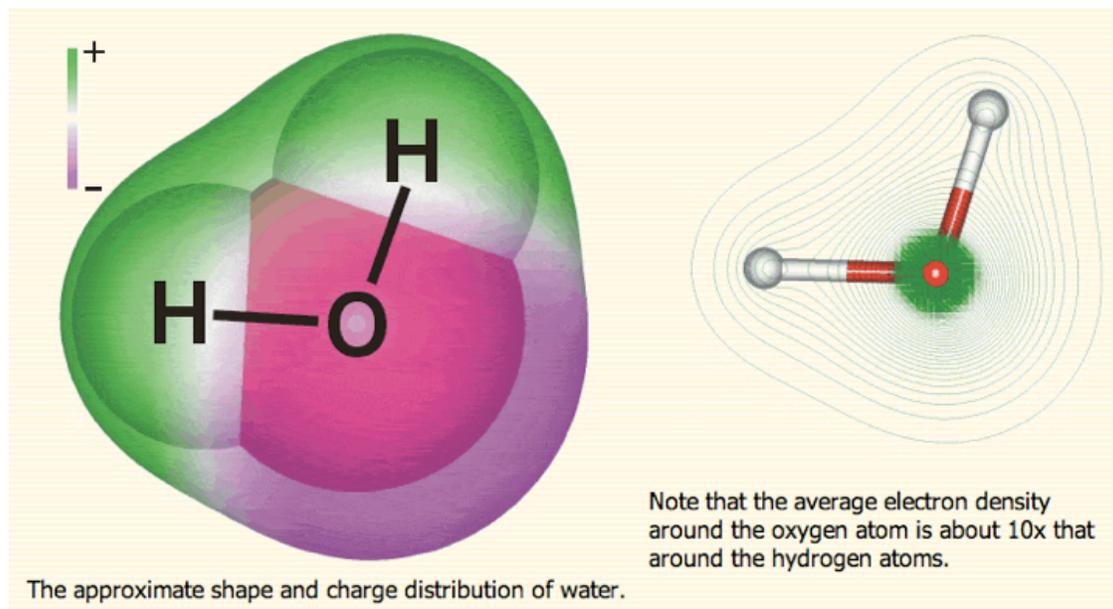
2 Retrieved from <http://namesofclouds.com/index.html>.

are not directly available to the senses; the classification is exhaustive (the typology covers all cloud formations); and the classification typically involves several levels of delicacy (deep fine grained typology). Terms derived from Latin (and sometimes Ancient Greek) are often deployed, in part to signal the uncommon sense technicality, in part because we run out of English words, and in part because deep down English speakers still associate uncommon sense with the languages from which they had to reclaim it some centuries after the French conquerors destroyed their native tradition of vertical discourse.

Comparable precision and delicacy is also found for decomposition. We know from Text [1] that clouds are made of water droplets, and we can pursue this further into the realms of chemistry, and physics³. There we learn that water is a V-shaped molecule, known chemically as H₂O (meaning two hydrogen and one oxygen atom bonded together into a molecule). Pushing further we might find that water molecules are symmetric (point group C_{2v}), with two mirror planes of symmetry and a 2-fold rotation axis; its electronic structure is modelled in Figure 1. Of special interest here is the way in which decomposition draws attention to the borders of disciplines, as we move from meteorology through chemistry to physics. This highlights the sense in which the borders of uncommon sense disciplines are in fact more weakly classified than their excluding field specific technicality might lead one to expect.

FIGURE 1

Water electronic structure (from <http://www.lsbu.ac.uk/water/molecule.html>)



3 Information retrieved from <http://www.lsbu.ac.uk/water/molecule.html>.

Turning from science to humanities, linguists exploring these issues were struck by the relative paucity of technicality in school subjects such as English, history and creative arts. Not, of course, that there was none. History, for example, does divide the past into a composition hierarchy of periods of time (e.g. Old Kingdom Egypt, New Kingdom Egypt, World War I, World War II) and past worlds feature unfamiliar entities (people, places, products, artefacts etc.) that have to be mastered. In addition, there are a number of socio-economic concepts that have to be explored (e.g. colonialism, imperialism, nationalism, communism, socialism, capitalism) in order to explain struggles over the control of resources both within societies and between (Martin et al., 2010). But what struck educational linguists more strongly was the abstract nature of the discourse students were expected to read and write, often featuring even more grammatical metaphor than had been found deployed to define and explain in physics, chemistry, biology and physical geography. The mode of the humanities in other words was equally, if not more abstract—and so equally, if not more challenging for students moving into discourse of this kind for the first time upon entering secondary school.

So, instead of reading *Mt Vesuvius erupted*, they had to deal with *the eruption of Mt Vesuvius*; instead of writing *he excavated Pompeii*, they had to manage *his excavation of Pompeii*. What was this abstraction for? There is no simple answer to this question. Part of the answer has to do with managing information flow in academic discourse, as discussed in relation to PERIODICITY in Martin and Matruglio (2013); compare the discussion of power composition in Martin (2015) and aggregation in Martin's paper in this issue. Another part of the answer has to do with explanation, since in history there is usually more than one factor influencing change and more than one effect ensuing (Martin, 2002, 2003). There may be multiple causes in other words (i. *past neglect*, ii. *damage*, and iii. *a failure to document carefully, if at all* below):

[3] Andrew Wallace states that while Pompeii is one of the most studied of the world's archaeological sites, it is perhaps the least understood, due to past neglect, damage, and a failure [[to document carefully, if at all]].

And there may be multiple effects (i. *greater documentation*, ii. *more archaeological artefacts left in site* and iii. *the breakthrough process of injecting liquid plaster into the body-shaped cavities* below):

[4] Fiorelli's stage of occupation allowed for greater documentation, more archaeological artefacts left in site and the breakthrough process of injecting liquid plaster into the body-shaped cavities made by solidified ash and the eventual decomposition of bodies.

Grammatical metaphor allows historians to parcel up multiple causes and effect inside the clause by way of managing the complexity of what leads on to or follows on from what.

Explaining the past moreover involves more than packaging up complex causes and effects; it also involves interpreting the kind of causal connection between the packages. Historical explanation is a finely nuanced process, involving degrees and types of influence; consider, for example, just a few of the ways in which we might relate Fiorelli's archaeology to its legacy:

[4] Fiorelli's stage of occupation

allowed for

greater documentation, more archaeological artefacts left in site and the breakthrough process of injecting liquid plaster into the body-shaped cavities made by solidified ash and the eventual decomposition of bodies.

[5] Fiorelli's stage of occupation

encouraged

greater documentation...

[6] Fiorelli's stage of occupation

contributed to

greater documentation...

[7] Fiorelli's stage of occupation

precipitated

greater documentation...

Cause in the clause is thus a critical resource nuancing history's interpretation of the past. The congruent resources of spoken discourse are nowhere near delicate enough.

We should also note here the role played by grammatical metaphor in targeting the attitudes that historians cultivate towards the past. The opening and closing paragraphs of the factorial explanation considered in Martin's paper in this issue for example feature negative appreciation of the conservation of Pompeii as an archaeological site.

[8] While Pompeii is one of the most studied of the world's archaeological sites, it has been plagued with serious conservation problems, including poor restoration work, damage from vegetation, pressure from tourism and poor site management...

As a result of this, the description of Pompeii as a victim of state neglect and indifference and an archaeological catastrophe of the first order is an apt one. Its ongoing destruction since its discovery in the 1590s has arguably resulted in a greater disaster than its initial destruction by the eruption of Mt Vesuvius one and a half millennia earlier.

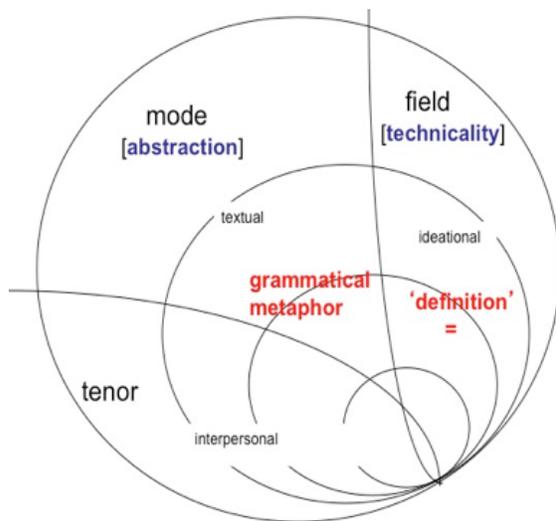
In its introductory paragraph, cause in the clause is deployed to set up the lexical metaphor whereby various factors infect Pompeii (i.e. a plague of i. *conservation problems*, ii. *poor restoration work*, iii. *pressure from tourism* and iv. *poor site management*). In the final

paragraph the packaging of Pompeii as a victim of neglect and an archaeological catastrophe is evaluated as *apt*; and its ongoing destruction is evaluated as an even greater *disaster* than its initial destruction by Mt Vesuvius. The requisite historical sensibility could not be more clear here—namely that archaeological sites are priceless treasures and need to be carefully conserved. In history, as in the humanities in general, demonstrating how you value what you know is every bit as important as demonstrating what you know.

In summary, by 1995 language in education research informed by SFL had arrived at a characterization of science oriented to field and featuring technicality, and a complementary characterization of the humanities oriented to mode and featuring abstraction. The critical linguistic resources at play in science concerned elaboration (across ranks and strata)—the resources whereby less specialized meanings are distilled as more specialized ones. The critical linguistic resources at play in the humanities concerned grammatical metaphor—the resources whereby explanations of change are proposed and evaluated. A rough outline of this phase of understanding is presented in Figure 2, setting aside genre and concentrating on field and mode in relation to metafunctions. For discussion of the genres underpinning this profile see Martin & Rose (2008) and Rose & Martin (2012); Schleppegrell (2004) provides an engaging introduction to uncommon sense school discourse for language educators.

FIGURE 2

Knowledge structure—an SFL perspective, circa 1995

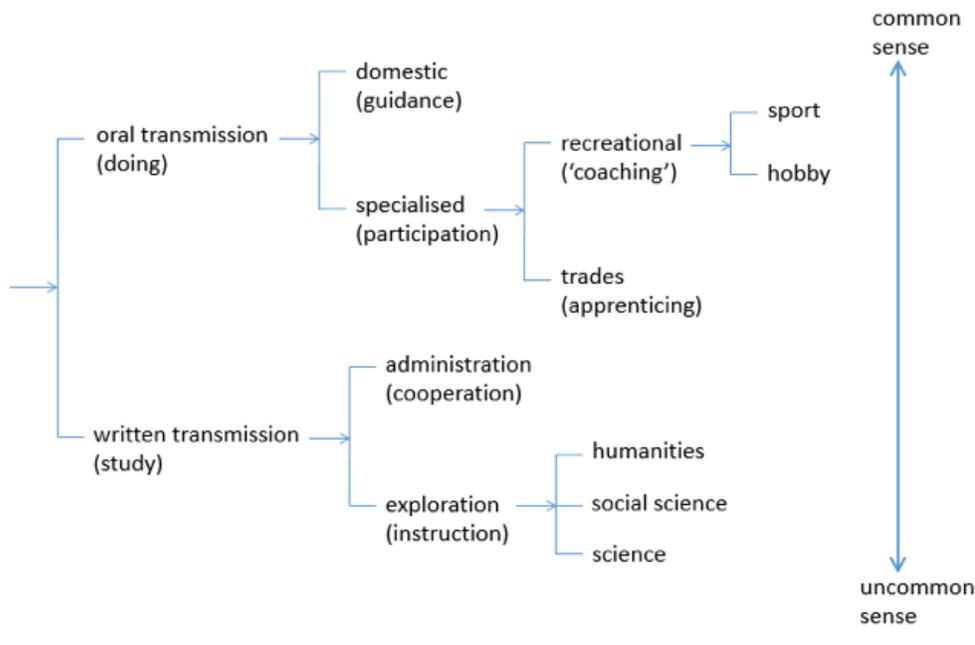


As far as relations among fields were concerned, Martin (1992: 544) proposed a crude mapping based on the implications of distinctive sequencing and taxonomy for the ways fields are learned. This typology is reproduced as Figure 3, with fields graded along a common sense to

uncommon sense cline⁴. As we will see below, an orientation to field of this kind was comparable to Bernstein's late work on knowledge structure and thus encouraged dialogue.

FIGURE 3

Field typology (Martin, 1992: 544)



3. SFL and Bernstein's 'knowledge structure'

SFL and sociological research using the work of Basil Bernstein have engaged in a productive transdisciplinary dialogue for decades (Martin, 2011a; Maton & Doran, forthcoming). Bernstein and Halliday began collaborating in the 1960s in London in a project involving sociologists and linguists that focused on Bernstein's theory of codes (see Bernstein, 1995, and Halliday, 1995, for discussion). Hasan (2009) developed this work in her studies during the 1980s of semantic variation in relation to gender and class in the language of pre-school mothers and children. Throughout the 1980s and 1990s 'Sydney School' literacy programmes drew on Bernstein's work on 'pedagogic discourse' to refine their pedagogy and curriculum and interpret the class basis of their struggles with traditional and progressivist/constructivist pedagogues (as canvassed in Martin, 1999, and Rose & Martin, 2012). As flagged in section 1 of this paper,

4 We are indebted to Jing Hao for this rendering of J. R. Martin's network from 1992.

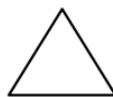
by the 2000s interaction around SFL's concept of field and Bernstein's concept of 'knowledge structure' came to the fore. At this point in our introduction, we discuss this notion from the perspective of SFL: what educational linguists found valuable about Bernstein's concept and why.

Fundamental to the ideas that gripped educational linguists at the turn of the century was Bernstein's distinction between 'horizontal discourse' and 'vertical discourse'.

A Horizontal discourse entails a set of strategies which are local, segmentally organized, context specific and dependent, for maximizing encounters with persons and habitats....This form has a group of well-known features: it is likely to be oral, local, context dependent and specific, tacit, multi-layered and contradictory across but not within contexts... a *Vertical discourse* takes the form of a coherent, explicit and systematically principled structure, hierarchically organized as in the sciences, or it takes the form of a series of specialized languages with specialized modes of interrogation and specialized criteria for the production and circulation of texts as in the social sciences and humanities (Bernstein, 2000: 157).

This is a late development of Bernstein's abiding concern with differences between common sense and uncommon sense and their implications for success and failure in education as shaped by the social backgrounds of students. The distinction resonates strongly with the everyday versus academic discourse opposition reflected in Figure 3 and which was the focus on the educational linguistic work on field and mode, reviewed in section 2 of this article.

Next, Bernstein made a distinction within vertical discourse between 'hierarchical knowledge structures' and 'horizontal knowledge structures'. For Bernstein, a hierarchical knowledge structure is "a coherent, explicit and systematically principled structure, hierarchically organized" (2000: 160) which "attempts to create very general propositions and theories, which integrate knowledge at lower levels, and in this way shows underlying uniformities across an expanding range of apparently different phenomena" (2000: 161). Bernstein uses a triangle to symbolize a knowledge structure of this kind, commenting in a footnote that there "is likely to be more than one triangle in a hierarchical knowledge structure" but that "the motivation is towards triangles with the broadest base and the most powerful apex" (2000: 172), where the apex refers to 'propositions' and the base to 'phenomena':



A horizontal knowledge structure is defined as "a series of specialized languages with specialized modes of interrogation and criteria for the construction and circulation of texts"

(2000: 162), such as often illustrated by the disciplines of the humanities and social sciences. Bernstein suggests that these segmented knowledge structures can be visualized as a series of L's (standing for their specialized languages).

$$L^1 \ L^2 \ L^3 \ L^4 \ L^5 \ L^6 \ L^7 \dots \ L^n$$

The motivation in hierarchical knowledge structures to subsume more data in more cohesive and economic theories is well-known—Einstein's relativity theory has to explain everything explained by Newton's classical mechanics and more, just as the search for a Grand Unified Theory attempts to embrace and go beyond the existing insights of relativity theory and quantum mechanics. The humanities are in a sense more modest in their claims, offering alternative interpretations of past ideas from particular points of view. The new interpretations present themselves as offering better interpretations of past ideas without necessarily subsuming predecessors (Martin, 2003). By way of illustration we might caricature traditional, Marxist, feminist and post-colonial readings of the conservation of Pompeii, focusing on agency (i.e. what is ultimately responsible for the destruction: a plague of problems, the concentration of wealth in private hands, irresponsible patriarchs or discourses of scientism).

[8] While Pompeii is one of the most studied of the world's archaeological sites, it has been plagued with serious conservation problems, including poor restoration work, damage from vegetation, pressure from tourism and poor site management.

[8'] While Pompeii is one of the most studied of the world's archaeological sites, the concentration of wealth in private hands in capitalist Italy have left the site with serious conservation problems, including poor restoration work, damage from vegetation, pressure from tourism and poor site management.

[8''] While Pompeii is one of the most studied of the world's archaeological sites, the non-custodial attitudes of the irresponsible patriarchs responsible for the site have left it with serious conservation problems, including poor restoration work, damage from vegetation, pressure from tourism and poor site management.

[8'''] While Pompeii is one of the most studied of the world's archaeological sites, the lack of interrogation of the prevailing discourses of scientism have left the site with serious conservation problems, including poor restoration work, damage from vegetation, pressure from tourism and poor site management.

At the first Sydney conference in 2004 (see section 1), Wignell suggested the social sciences are better characterized as 'warring triangles', since they model themselves on science and

struggle for institutional rather than epistemological ascendancy—when compared with the humanities where technicality and the drive to integration via general models and propositions is less strong. Martin (2014) explores the hierarchical potential of SFL as far as the evolution of one warring triangle is concerned; for discussion of some of the competing centrifugal tendencies in SFL which implicate segmentation and the emergence of new theories, see Martin (2011b).

These characteristics were glossed by Muller (2007) in terms of what he called ‘verticality’ and ‘grammaticality’. First, ‘verticality’ characterized how Bernstein’s ‘knowledge structures’ progress: via ever more integrative or general propositions or via the introduction of a new ‘language’ (theory or approach) which constructs a “fresh perspective, a new set of questions, a new set of connections, and an apparently new problematic, and most importantly a new set of speakers” (Bernstein, 2000: 162). This helps clarify Bernstein’s opposition of hierarchical to horizontal knowledge structures as a claim about how intellectual fields progress, not about the number of theories struggling for legitimacy at any given time. In some intellectual fields (illustrated best by natural science) there is relatively collegial consensus over what counts as progress (i.e. a theory that explains more phenomena) whereas in other intellectual fields (such as many social sciences and humanities) such collegial consensus on what constitutes progress is less evident. Second, ‘grammaticality’ described how theoretical statements deal with their referents. The stronger the grammaticality, the more stably a knowledge structure can generate empirical correlates and the more unambiguous because the more restricted the field of referents. Where correlates are clear, there are shared referents for competing knowledge claims; where they are unclear or vague, the tendency is for endless reinterpretation of ‘data’ that cannot be compared. One thinks, for example, of the aims of scientific experiment in contrast to the hermeneutic interpretations of texts common in many humanities disciplines.

Verticality and grammaticality echo Bernstein’s model of individual theories as comprising internal (L¹) and external (L²) ‘languages of description’ (2000: 131-41). L¹ “refers to the syntax whereby a conceptual language is created” or how constituent concepts of a theory are interrelated; and L² “refers to the syntax whereby the internal language can describe something other than itself” (2000: 132) or how a theory’s concepts are related to referents. Grammaticality also rearticulates Bernstein’s notions of strong and weak “grammar” (2000: 163-166). From the perspective of SFL such terminology is potentially confusing. In linguistics, L1 and L2 are generally used to distinguish between a speaker’s native tongue (L1) and a second language (L2); and the term ‘grammar’ (or ‘syntax’, which Bernstein also used) refers to one level of organization in language, not the conceptual organization of a theory. In addition, the term ‘grammaticality’ in formal linguistics concerns whether an utterance is well-formed with respect to the syntactic rules formalized for a language. Such terms are thus more likely to mislead linguists than guide them.

This is unfortunate because Bernstein's distinction between internal and external languages of description, or L^1 and L^2 (with numbers in superscript), is useful for clarifying relations between theory and description in SFL. Over the years some degree of confusion has arisen in SFL about the nature of concepts within the framework. Much of the extravagant conceptual array of SFL is viewed by proponents as an internal language of description when it is in fact an external language for engaging with a specific object of study. This is to say, that much SFL theory is not a description of language *per se* but of a specific language or language variety. This confusion may arise in part from the name of Halliday's well-known book, *An Introduction to Functional Grammar* (1985), which is not for the most part an introduction to functional grammar (which would constitute an internal language or L^1) but rather offers a description of English grammar (an external language for relating functional grammar to the specific object of study of English)⁵. It may also arise in part from the widespread consumption of SFL descriptions of language and other modalities of communication by users untrained in SFL theory; Martin (in press) discusses this problem in the context of appraisal "theory". To reinforce this point for systemicists, consider the covers of the second (1994) and third (2004) editions of Halliday's grammar. The 1994 cover involves a circular image of a colour spectrum around which process types are arranged topologically: this is a part of Halliday's description of English grammar (an external language). The 2004 cover involves a series of rectangular images representing various dimensions of SFL theory—stratification, metafunctional, rank and instantiation in particular (the internal language). The typical way in which linguists talk about internal and external languages of description is in terms of theory and description; their ability to enact a productive dialectic between these languages of description is another matter (see Matthiessen & Nesbitt 1996). Among the many problems which arise when description (L^2) is mistaken for theory (L^1) include locking the specificities of one language into the central core of the theory, restricting its capacity to embrace language more generally and thereby constraining knowledge-building.

Figure 4 (created by Martin for the 2008 Sydney conference discussed in section 1) summarizes the common understanding in SFL by the mid-2000s of how Bernstein's concepts of 'knowledge structures' could be viewed in relation to subject areas in education. This, we should emphasize, represented a recontextualization of sociological concepts by SFL scholars attempting to enact the ideas in research. For example, Muller (2007) stated that 'verticality' was categorical: knowledge structures either had it or did not, rather than exhibiting degrees of verticality. Instead, the SFL version arranged knowledge structures on a cline of degrees of verticality and grammaticality and adopted Wignell's metaphor of 'warring triangles' to describe the social sciences, with the larger triangle in the centre representing the tendency

5 For introductions to functional grammar, see Matthiessen & Halliday (2009) and Martin (2014).

yet segmentalized discipline of mathematics fit in a topology of this kind? As suggested by these and other questions, the value of these ideas lay in highlighting issues about the morphology of intellectual fields. They represent a starting point that raised more questions than they answered. However, such questions were also being raised within social realism itself. Indeed, the answers offered by Maton's Legitimation Code Theory recast the inherited model in ways that not only enabled many of these problems to be resolved but also led to an intensification of dialogue and collaboration between the two disciplinary traditions.

4. Legitimation Code Theory

Legitimation Code Theory (LCT) extends and integrates Bernstein's code theory to embrace a greater range of phenomena within a more systematic and economical framework (Maton, 2014b, 2016a). LCT does not begin solely from 'knowledge structures'; it builds on concepts from across Bernstein's framework, as well as other theories. However, in terms of introducing recent dialogue with SFL, the model outlined above is a useful starting point because, when developing LCT, Maton was addressing similar questions to those raised by educational linguists.

Put simply, Maton (2000, 2007, 2009, 2011, 2014b) argued that Bernstein's concepts of 'discourses' and 'knowledge structures' were good to think with but less useful to analyse with. The concepts valuably highlighted issues of how intellectual fields develop over time, but did not provide the means to engage in empirical research about those issues. The model suffered from two main problems highlighted by the modifications made by SFL scholars when trying to make it work. The first problem is revealed by what can be called 'Wignell's mixture'. As discussed in section 3, when attempting to relate the concepts to the realities of social science, Wignell suggested the notion of 'warring triangles' that mixed attributes from hierarchical and horizontal knowledge structures. However, attempts to use the concepts to study other disciplines, including the humanities revealed this mixture was not unique to social science (Maton, 2000, 2010b). Every intellectual field seems to exhibit characteristics of both knowledge structures—they all involve 'warring triangles'. The problem this reflected was that Bernstein's model offered binary types. Though one can easily find suggestive general examples that resonate with descriptions of the knowledge structures (as we did ourselves in section 3), detailed study of empirical data soon reveals that no actual intellectual field readily fits into either category.

A second problem reflects what can be called 'Martin's cline'. The use by Martin of a continuum of strengths (Figure 4) to represent 'verticality' and 'grammaticality' (against Muller's own descriptions of them as categorical differences) aimed at moving beyond the strongly-bounded types of Bernstein's model. As Bernstein himself stated, dichotomous types are 'li-

mitted' and 'very weak' in their 'generating power' (2000: 124); the key is to conceptualize the organizing principles that generate such types. However, 'verticality' and 'grammaticality' did not offer the means of doing so. Ironically, the concepts were characterized by weak grammar and their unclear referents did not enable empirical research.

Attempts by SFL scholars in the mid-2000s to modify Bernstein's model thus reflected fundamental problems with his concepts. The key issue was that they redescribed empirical characteristics: they highlighted the presence or absence of knowledge-building but not its basis. The question remained as what gives a knowledge structure 'verticality' or 'grammaticality' and what makes internal or external languages of description 'strong' or 'weak'. The need was to conceptualize the organizing principles underlying knowledge practices. This was precisely what Maton had been doing by developing LCT since the late 1990s.

LCT is a sociological framework for researching and changing practice that comprises a multi-dimensional conceptual toolkit⁷. There are currently five dimensions: Specialization, Semantics, Autonomy, Temporality and Density. Each dimension comprises a series of concepts centred on capturing a set of organizing principles underlying dispositions, practices and contexts as a form of *legitimation code* that is named after that dimension. The two most relevant dimensions to this special issue are Specialization and Semantics, which are centred on exploring *specialization codes* and *semantic codes*, respectively. For a fuller introduction to these two dimensions see Maton (2014b, 2016a), which defines and illustrates the concepts, and Maton et al. (2016b), which sets out how to enact the concepts in empirical research.

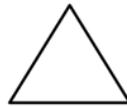
4.1. Specialization (LCT)

Specialization was the first dimension of LCT to be developed (Maton, 2000, 2004, 2006, 2007; Moore & Maton, 2001). The concepts have been widely used in research, including by numerous studies also utilizing SFL (see Maton & Doran, forthcoming; Maton et al., 2016a). Most relevant to our focus in this paper is that Specialization helped resolve problems indicated by Wignell's mixture and Martin's cline in two main ways. First, the concept of 'knower structures' highlighted that knowledge structures were not the only attribute of social fields; and, second, the concept of 'specialization codes' revealed the organizing principles generating different structures of knowledge and knowers.

7 For the rapidly growing field of studies enacting LCT, see the website: <http://www.legitimationcodetheory.com>

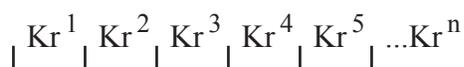
4.1.1. Knower structures

First, Specialization extends Bernstein's concepts by additionally exploring intellectual and educational fields in terms of their *knower structures* which can be horizontal or hierarchical. A *hierarchical knower structure* is "a systematically principled and hierarchical organization of knowers based on the construction of an ideal knower and which develops through the integration of new knowers at lower levels and across an expanding range of different dispositions" (Maton, 2014b: 70). This can be represented as a triangle, with an ideal knower at the apex and a range of novices at the base:



We can illustrate this knower hierarchy by considering the ways in which, as education has expanded over the past century, the humanities have aimed at embracing a greater range of learners and cultivating their dispositions to inculcate a particular 'gaze', such as a literary or artistic gaze. In other words, over time the base embraces more kinds of knowers and the aim is to cultivate or socialize their dispositions towards becoming similar to the ideal knower at the apex of the triangle and thereby move those knowers up the triangle.

In contrast, a *horizontal knower structure* is "a series of strongly bounded knowers, each with specialized modes of being, thinking, feeling and acting, with non-comparable dispositions based on different trajectories and experiences" (Maton, 2014b: 92). This can be represented as a series of segmented knowers ('Kr'):



This can be illustrated by claims made by many proponents of natural science that the social profile of scientists is irrelevant for scientific insight and anyone can claim legitimate knowledge so long as they follow the correct principles and procedures. In terms of their non-scientific dispositions, scientists thereby represent a segmented series of strongly bounded knowers—they can be very different to each other (Maton, 2014b: 91).

Each social field of practice is, then, more than just a knowledge structure, it is also a

knower structure⁸. Specialization brings these together to construe social fields as *knowledge-knower structures*. This begins to resolve the problem of binary categories and Wignell's mixture. The humanities and sciences illustrate that every social field may involve a mixture of triangles and segments: a hierarchical knowledge structure (triangle) may be accompanied by a horizontal knower structure (segments), and vice versa. Specialization moves beyond a dichotomous binary to describe four types, comprising hierarchical/horizontal knowledge structures and hierarchical/horizontal knower structures. This also avoids a deficit model of the humanities: social fields that exhibit horizontal knowledge structures may exhibit hierarchical knower structures. That is to say, the humanities primarily aim at cultivating or socializing knowers rather than cumulative knowledge-building. Moreover, as Maton (2010, 2014b) has shown, such hierarchical knower structures do enable some knowledge-building within a knowledge segment. Put simply, they too exhibit a series of mini-triangles of knowledge.

4.1.2. Specialization codes

Martin's cline reflected a need to conceptualize the organizing principles generating these different structures of knowledge and, now, knowers. In Specialization, these organizing principles are given by *specialization codes* comprising *epistemic relations* (ER) between knowledge claims and their object and *social relations* (SR) between practices and their subject, author or actor. Each relation may be more strongly (+) or weakly (-) bounded and controlled or, simply put, more or less emphasized as the legitimate basis of practices, beliefs and identity⁹. These two strengths may be varied independently to generate *specialization codes* (ER+/-, SR+/-). As shown in Figure 5, these can be visualized as the *specialization plane*, a topological space with four principal modalities:

- *knowledge codes* (ER+, SR-), where possession of specialized knowledge, principles or procedures concerning specific objects of study is emphasized as the basis of achievement, and the attributes of actors are downplayed;
- *knower codes* (ER-, SR+), where specialized knowledge and objects are downplayed and

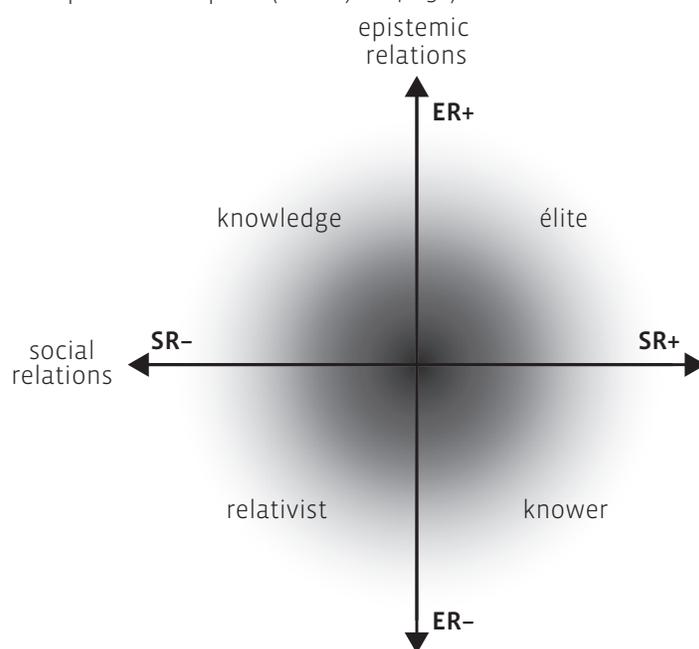
8 We shall refer to educational and intellectual fields as 'social fields' to avoid confusion with the SFL register variable field and to highlight that these LCT concepts are applicable not just to education but to all social fields of practice (law, medicine, politics, etc.).

9 See Maton (2014b: 31) for a distinction between *focus* and *basis* of practices. For example, knowledge claims may *focus* on a 'knower' issue (such as physical experience of pain) but on the *basis* of specialized knowledge (such as a medical report). Specialization codes concern the *basis* rather than the *focus* of practices—organizing principles underlying practices rather than their content.

- the attributes of actors are emphasized as measures of achievement, whether viewed as born (e.g. ‘natural talent’), cultivated (e.g. ‘taste’) or social (e.g. feminist standpoint theory);
- *élite codes* (ER+, SR+), where legitimacy is based on both possessing specialist knowledge and being the right kind of knower; and
 - *relativist codes* (ER-, SR-), where legitimacy is determined by neither specialist knowledge nor knower attributes—‘anything goes’.

FIGURE 5

The specialization plane (Maton, 2014b: 30)

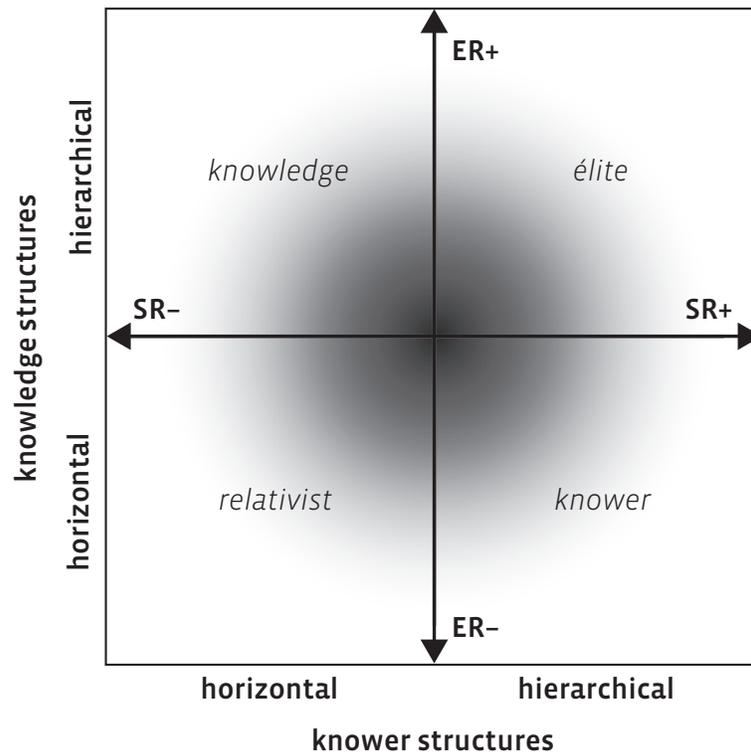


Specialization codes generate knowledge-knower structures of different kinds. Stronger and weaker epistemic relations generate hierarchical and horizontal knowledge structures, respectively; stronger and weaker social relations generate hierarchical and horizontal knower structures, respectively. In Figure 6 we have added these structures to the specialization plane to make clear how specialization codes are the organizing principles underlying the knowledge-knower structures of social fields. For example, knowledge codes (ER+, SR-) underlie social fields with hierarchical knowledge structures and horizontal knower structures. Specialization codes thereby offer a means of conceptualizing the organizing principles of different kinds of educational and intellectual practices.

More significantly, LCT provides a fundamentally different approach to conceiving knowledge practices that offers a number of advantages over the previous model. First, Specialization moves beyond a limited number of structures. We can now think in terms of both a

FIGURE 6

Specialization codes and knowledge-knower structures



typology (four kinds of knowledge–knower structures generated by four codes) and a topology in which there are endless possibilities for capturing difference. For example, returning to knowledge structures, one can describe different degrees of stronger epistemic relations (anywhere in the top half of Figure 5 or Figure 6), thereby capturing differences in how hierarchical each knowledge structure may be. (The same is true, of course, for stronger social relations and differences in how hierarchical each knower structure may be). Second, we can capture differences not only between subject areas but also *within* each subject area. Rather than having to fit a diverse set of practices within a single category, a set of instances can be represented as a scatter pattern across the plane, showing the diversity of codes present and which code dominates the context. Third, the concepts are far more versatile in application. Where Bernstein’s concepts were defined in terms of whole intellectual fields or theories, specialization codes can be used to analyse any level, from subject areas to individual pedagogic or textual practices. Fourth, instead of analysing practices in terms of static structures, we can use the specialization plane to plot changes in the pattern, tracing changes over time as relations are strengthened or weakened (ER \uparrow / \downarrow , SR \uparrow / \downarrow). This enables a more dynamic analysis of *code shift* (when the dominant code changes—movement between quadrants of the plane) and *code drift* (changes within a code—movement within a quadrant). Fifth, specialization codes can be

enacted to analyse not only forms of knowledge but also a wide variety of other practices, such as pedagogy and assessment, as well as the dispositions of actors. This enables a more relational analysis of degrees of *code clash* and *code match*, such as between learners' dispositions and pedagogic practices or between curriculum and pedagogy. Last, specialization codes can be enacted in empirical research. As a rapidly growing body of studies is showing, the concepts can be used in fine-grained analysis of empirical data (e.g. Maton et al., 2016b).

There is a lot more to the dimension of Specialization than we can cover here (see Maton, 2014b). However, this gives a flavour of some key concepts that have been enacted alongside SFL in transdisciplinary research. Specialization is, though, not the only dimension of LCT relevant to our narrative as it does not embrace all features of social fields. For example, questions remain of how some social fields can build knowledge over time while others create knowledge that is locked into its context or, from the perspective of SFL, how linguistic resources for the construction of uncommon sense knowledge, such as 'grammatical metaphor', are realized in knowledge practices. For these and other issues, we turn to another dimension of LCT.

4.2. Semantics (LCT)

The LCT dimension of Semantics (not to be confused with 'discourse semantics' in SFL) was developed from the late 2000s (Maton, 2009, 2011, 2013, 2014b) in response to two stimuli. First, empirical studies enacting concepts from Specialization 'spoke back' to the framework, highlighting issues of context-dependence and condensation of meaning that had yet to be theorized. These issues had also been raised by Bernstein's model (2000) of discourses and knowledge structures but not explicitly and systematically conceptualized. Second, collaborative studies with SFL scholars raised questions of how linguistic features such as 'grammatical metaphor' were expressed in knowledge practices. The dimension of Semantics construes social fields of practice as *semantic structures* whose organizing principles are conceptualized as *semantic codes* comprising *semantic gravity* and *semantic density*.

Semantic gravity refers to the degree to which meaning relates to its context. Where semantic gravity is stronger (SG+), meaning is more dependent on its context; where semantic gravity is weaker (SG-), meaning is less dependent on its context. Semantic gravity traces a continuum of strengths. One can also analyse *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 refers to condensation of meaning within practices. Where semantic density is stronger (SD+), more meanings are condensed within practices; where semantic density is weaker (SD-), fewer meanings are condensed. This strength is not intrinsic to a practice but rather relates to the *semantic structure* within which that practice is located. For

example, 'gold' commonly denotes a bright yellow, shiny and malleable metal used in coinage, jewellery, dentistry, and electronics. However, within Chemistry gold is related to an atomic number, atomic weight, electron configuration, and many other meanings which involve compositional structures, taxonomies, and explanatory processes. It is thus located within a complex semantic structure that imbues the term with a greater range of meanings. Put another way, the meaning has a greater number of relations to other meanings (see the two papers by Maton and Doran in this issue). Semantic density traces a continuum of strengths which can be dynamized to describe *strengthening* semantic density (SD↑), such as moving from a simple symbol towards a more technical concept, and *weakening* semantic density (SD↓), such as 'unpacking' technical concepts into simpler terms.

The strengths of semantic gravity and semantic density may be varied independently to generate *semantic codes* (SG+/-, SD+/-). As shown in Figure 7, these can be visualized as the *semantic plane*, a topological space 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 condense fewer meanings; and
- *worldly codes* (SG+, SD+), where legitimacy is accorded to relatively context-dependent stances that condense manifold meanings.

The concepts should sound familiar from our earlier introduction to Specialization: there are structures, two constitutive relations, four codes, a plane, etc. This is because all dimensions of LCT share similar properties (see Maton, 2016b). Rather than exploring different kinds of practices, they conceptualize different organizing principles that may underlie the same practices. Thus, dimensions can be and are often used together in research (e.g. Maton et al., 2016b). Accordingly, the advantages we outlined above of thinking in terms of Specialization also hold for Semantics: the concepts enable both a typology and a topology, allow for analysis of code shift and code drift, can be used for all kinds of practices, and enable us to see code clashes and code matches. In doing so, they have further helped resolve questions raised of the model of knowledge structures (section 3) by systematically conceptualizing and enabling empirical research into issues highlighted by notions such as 'verticality'. For example, unlike the earlier model, and indeed, most education debates that posit oppositions between 'theoretical' and 'practical' knowledges, semantic codes do not exclude what SFL terms 'specialized' discourse (trades, crafts, etc.). These social fields exhibit relatively strong semantic gravity (like 'practical' or horizontal forms) but also relatively strong semantic density (like 'theoretical' or hierarchical forms): *worldly codes* (SG+, SD+).

FIGURE 7

The semantic plane (Maton, 2016a: 16)

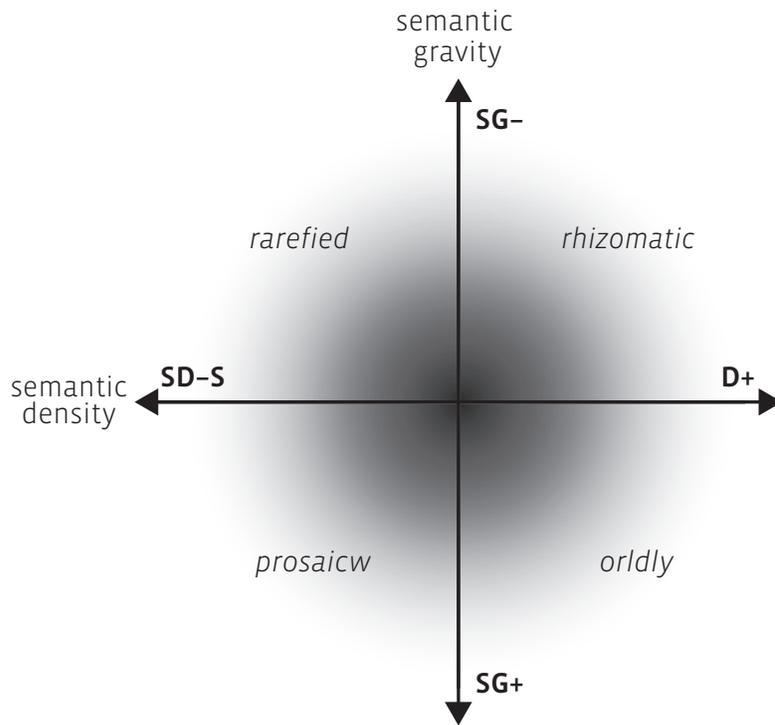
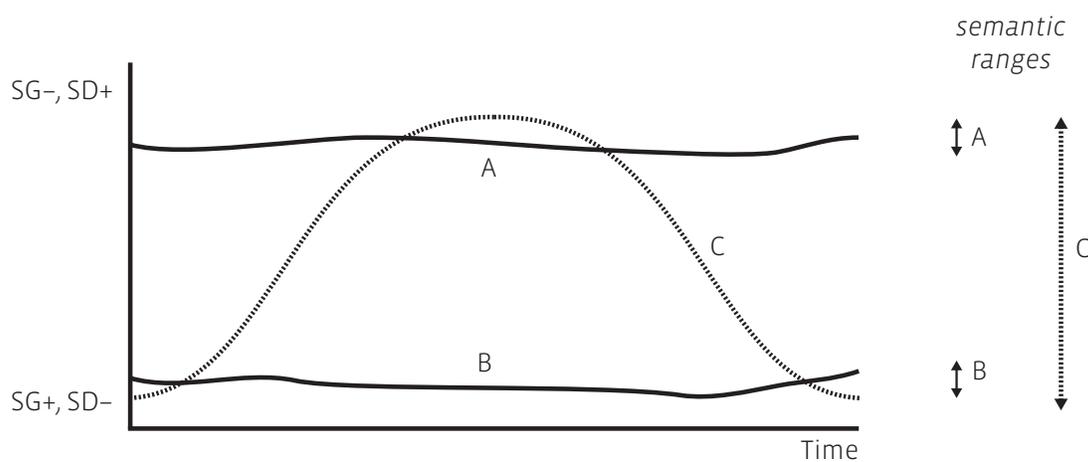


FIGURE 8

Three illustrative semantic profiles (Maton, 2014b: 143)



Another affordance of LCT code concepts is shown by the analytic method of *profiling*. Tracing strengths of semantic gravity and semantic density over time (such as unfolding of an intellectual field, classroom practice, curriculum, or a text) reveals a *semantic profile* and an

associated *semantic range* between their highest and lowest strengths. Figure 8 offers a heuristic representation of three simplified profiles and their ranges: a high *semantic flatline* (A), a low *semantic flatline* (B), and a *semantic wave* (C). The value of profiling is being illustrated by a growing body of research that is revealing further ‘rules of the game’ for achievement and bases of cumulative knowledge-building across different kinds of practices (Maton, 2014a; Maton et al., 2016b). This includes two major research projects enacting SFL and LCT together that provide a context for the papers collected in this special issue.

5. SFL and LCT as complementary frameworks

LCT is being increasingly used alongside concepts from across the framework of SFL. We began this article with a review of SFL work in the 1990s on the register variable field. As we discussed, this concern with field helped bring educational linguists into engagement with Bernstein’s notions of ‘discourses’ and ‘knowledge structures’, which in turn brought them into dialogue with LCT. However, the ongoing exchange between SFL and LCT has not been confined to field. Collaboration and exchanges are involving mode, field, APPRAISAL, individuation/affiliation, and many other areas of SFL. Moreover, studies enacting both frameworks range across issues in education, including academic writing (Hood, 2016), music education (J. L. Martin, 2016), and second language learning (Meidell Sigsgaard, 2013), as well as other social fields such as law (Martin et al., 2012), the armed services (Thomson, 2014) and parliament (Siebörger & Adendorff, 2015). As we discuss in Maton et al. (2016a), enacting both theories together offers greater explanatory power, challenges deeply-held beliefs and provokes new theoretical developments¹⁰. Here space allows us to only give a flavour of this research. To do so, we briefly introduce two major research projects enacting SFL and LCT together, called DISKS and PEAK.

The first research project is the DISKS project into ‘Disciplinarity, Knowledge and Schooling’, a three-year study (2009-11) based at the University of Sydney in Australia¹¹. The overarching aims were to explore knowledge-building in secondary school history and science lessons and develop pedagogic practices that could enable such cumulative progress. The study comprised data collection, data analysis, and a pedagogic intervention. Data collection gathered curriculum documents, student work products and video-recordings of 100 lessons in years 8 (ages 13-14) and 11 (ages 16-17) of six secondary schools in urban and rural New

10 For how to enact both theories together in research, see Maton et al. (2016a); for how they are shaping each other, see also Martin (2011a), and Maton & Doran (forthcoming).

11 DISKS was led by Peter Freebody, J. R. Martin and Karl Maton, and funded as an Australian Research Council Discovery Project (DP0988123).

South Wales, Australia. Lessons were in Science (year 8) or Biology (year 11) and Ancient History or Modern History (depending on school). Analysis of classroom data focused on phases in which knowledge was actively transformed in some way. The analysis stage drew on the LCT dimensions of Specialization and Semantics and on many areas of SFL focused on construal of uncommon sense discourse, including IDEATION, APPRAISAL, PERIODICITY, and grammatical metaphor in relation to field and mode. From these analyses, ideas were chosen that had direct implications for pedagogic practice and which could be conveyed to teachers in a short period of time for the intervention. Specifically, this focused on the ideas of ‘semantic waves’ from LCT and ‘power trio’ from SFL.

Space precludes detailing results here; see papers collected in Martin and Maton (2013). In brief, several profiles were revealed in analyses of classroom data (Maton, 2013), including *semantic waves* that trace movements between decontextualized and context-dependent meanings and between simpler and more complex meanings (see Figure 8, earlier above). This wave pattern enables the knowledge expressed to be transferred beyond a specific context and connect up with other meanings, aiding knowledge-building. SFL analyses highlighted how these movements in knowledge practices are associated with the employment by actors of complexes of linguistic resources. Of the wide array of such resources, control of technicality, grammatical metaphor, and PERIODICITY were highlighted as teachable in a short period of time, and more accessibly described as ‘power words’, ‘power grammar’, and ‘power composition’, respectively (Martin, 2013). In a pedagogic intervention six teachers were then trained to model semantic waves and bring to students’ consciousness the ‘power trio’ enabling these transformations (Macnaught et al., 2013) using the Sydney School notion of ‘joint construction’ in which teachers and students work together to construct meanings (Rose & Martin, 2012). A second major project called ‘PEAK’ (2012-16) is building directly upon this work by enacting SFL and LCT to explore knowledge-building in greater detail across whole units of study and embracing the role of technological resources and images in classroom practices¹².

These studies challenged existing ideas and provoked theoretical development in both SFL and LCT. This represents the immediate context to papers in this special issue by Martin and by Maton. The capacity of ‘semantic gravity’ and ‘semantic density’ to conceptualize organizing principles associated with complexes of linguistic practices stimulated Martin into rethinking the register variables field and mode. Highlighting that linguistic theorizations of context-dependence and condensation of meaning are not as clear as many SFL scholars assume, Martin proposes a more comprehensive account in terms of ‘presence’ and ‘mass’. Martin and Matruglio (2013) defines ‘presence’ as concerning context-dependence and invol-

12 PEAK is led by Karl Maton, J. R. Martin, Len Unsworth and Sarah Howard, and funded as an Australian Research Council Discovery Project (DP130100481).

ving ‘implicitness’ (concerning textual resources such as exophoric reference to the outside situation), ‘negotiability’ (mobilizing interpersonal resources around the arguability of a proposal or proposition), and ‘iconicity’ (the amount of ideational grammatical metaphor). In this special issue, Martin turns to the issue of condensation of meaning and explicates the notion of ‘mass’. Central to this discussion is consideration of technicality (the distillation of ideational meaning in terms, symbols and diagrams), iconization (charging ideas with values) and aggregation (the synoptic accumulation of knowledge, in often multimodal texts). These new concepts characterize the array of linguistic resources potentially at stake during changes in semantic gravity and semantic density of knowledge practices—a matter for further empirical research.

Such influence is not a one-way street. Working in DISKS and PEAK provoked Maton into developing means for semantic gravity and semantic density to be used to analyse discourse. In two connected papers in this issue, Maton and Doran outline a ‘translation device’ for enacting semantic density in the analysis of English discourse. These tools are unprecedented in the intellectual traditions LCT builds upon and bring sociological analysis closer to the kind of detailed exploration of discourse characteristic of SFL. Similarly, Martin’s ‘presence’ and ‘mass’ (see Martin’s paper, this issue) allows SFL to mobilize its vast descriptive array to understand context-dependence and condensation in more powerful ways than ever before. Thus major advances in each theory are being provoked by engagement with its companion.

These and similar genuinely transdisciplinary studies have encouraged a range of further research. In this special issue, for example, Vidal Lizama focuses on classroom discourse in Chilean popular education. Drawing on a range of SFL discourse semantic resources she shows how a functional linguistic analysis of classroom interaction highlights the specialization codes of learning activities using LCT, revealing the kinds of knowledge and knowers being legitimated. Hood turns to knowledge building in academic discourse, emphasising the importance of considering lectures as interactive multimodal events. Drawing in particular on SFL’s concept of presence (Martin & Matruglio, 2013) she explores the nature of intermodal explanation in a biology lecture, relating this to the LCT concept of ‘semantic gravity’ and changes in the context dependence of the knowledge being expressed. Doran explores the role played by mathematics in physics education, paying special attention to the complementary genres of derivation and quantification and the role they play in construing physics knowledge. Drawing on the dimension of Semantics from LCT he clarifies the sense in which mathematics is used both to develop new knowledge in the field (thereby strengthening semantic density) and to bring this knowledge to bear on specific phenomena in the material world (via relatively strong semantic gravity).

We hope that by bringing together cutting-edge papers that illustrate these theoretical developments and reveal the greater explanatory power and insights into education and

knowledge offered by enacting SFL and LCT together, this special issue will give you a flavour of the excitement, energy and explanatory power this transdisciplinary work is generating.

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