Knowledge-building

Educational studies in Legitimation Code Theory

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3 LCT in mixed-methods research

Evolving an instrument for quantitative data

Karl Maton and Sarah K. Howard

Transcending the divide between quantitative and qualitative methodologies.

Introduction

A mantra of social science declares a fundamental divide between the quantitative and the qualitative that involves more than methods. According to this depiction, the two methodologies are intrinsically associated with a range of ontological, epistemological, political and moral stances. Each of these constellations of stances is strongly integrated, such that choice of method is held to involve a series of associated choices. Each constellation is also strongly opposed to the other, along axes labelled positivism/constructivism, scientism/humanism, conservative/critical, old/new, among others. These 'binary constellations' (Maton 2014b: 148–70) offer a forced choice between two tightly-knit sets of practices that are portrayed as jointly exhaustive and mutually exclusive. So widespread is this methodological binarism that many scholars 'are left with the impression that they have to pledge allegiance to one research school of thought or the other' (Johnson and Onwuegbuzie 2004: 14).

A competing mantra disclaims this divide. Distinctions underpinning the picture of binary constellations have been regularly dissolved. Arguments that one deals with numbers, the other with words, one studies behaviour, the other reveals meanings, one is hypothetico-deductive, the other inductive, one enables generalization, the other explores singular depth, among others, have been repeatedly undermined (e.g. Hammersley 1992). Indeed, the death of the divide is frequently declared. Calls for 'transcending' (Salomon 1991) or 'getting over' (Howe 1992) the quantitative–qualitative debate and arguments for mixed-methods research (Brannen 2005; Johnson and Onwuegbuzie 2004) are recurrent. These calls highlight how the methodologies offer complementary insights for research and demonstrate that eschewing either methodology on principle is unnecessarily renouncing potential explanatory power. However, the call to mixed-methods research remains more breached than honoured. Methodological monotheism

remains dominant – studies of education and society typically adopt *either* quantitative *or* qualitative methods. As we shall discuss, the former is typically associated with the influence of psychology and the latter is often claimed as emblematic of sociology. Studies utilizing the sociological frameworks on which Legitimation Code Theory (LCT) builds have echoed this pattern by overwhelmingly adopting qualitative methods. Accordingly, Part I of this volume begins by exploring how LCT concepts can be enacted in qualitative research (Chapter 2). However, LCT is not limited to one methodology and a growing body of mixed-methods research is engaging with both qualitative and quantitative data. In this chapter we illustrate how this research works and the gains it offers.

For resolutely qualitative researchers, the prospect of reading anything quantitative, even in mixed-methods research, may be unenticing. However, it would be a mistake to pass over this chapter, for several reasons. First, we offer insights into research practice that might surprise such scholars. As Bourdieu argued, 'methodological indictments are too often no more than a disguised way of making a virtue out of necessity, of feigning to dismiss, to ignore in an active way, what one is ignorant of in fact' (Bourdieu and Wacquant 1992: 226). Our aim is to contribute towards removing this reason for one-sidedness. We show, for example, how quantitative methods confound their common portrayal as neat, straightforward and procedural; they are complex and involved and require craft work and judgement. Our focus is, therefore, more practical than metaphysical. We shall not enter seemingly endless debates over whether the 'quantitative–qualitative divide' refers to paradigms, epistemologies or methods and whether these are complementary or incommensurable. Rather, we discuss the development of an instrument for enacting LCT concepts in quantitative methods and ground this account in real examples of mixed-methods research. Specifically, we trace the evolution of an instrument for embedding *specialization codes* within questionnaires through its creation for research into school music and then its development within studies of educational technology. Given that mathematics can be off-putting to the noviciate, we minimize discussion of statistics and explain measures in lay terms.

Second, this is much more than a story of quantitative methods. The evolution of the instrument both shaped qualitative methods and was shaped by the data they generated, offering insights into how qualitative research can more fully engage with LCT. Its development also involved intimate dialogue with theory that shed fresh light on LCT itself, making explicit the 'gaze' embodied by the framework (Chapter 1, this volume). We shall highlight wider lessons learned about the craft of enacting LCT in research, lessons of direct relevance for studies using any methods.

Third, we shall illustrate the explanatory power offered by using quantitative and qualitative methods together, such as providing a robust basis for detailed findings, identifying wider-scale trends typically inaccessible to qualitative methods that provide a context for their data, and facilitating

knowledge-building through greater replicability across contexts and over time. For example, the technology studies built directly on the music studies to cumulatively develop the instrument and generated probably the largest data set in code sociology: 97,386 responses (83,937 student and 13,449 staff surveys) on the organizing principles of academic subjects, alongside 20 in-depth qualitative case studies of secondary schools. This offers a foundation of substantial breadth and depth for making claims about knowledge practices across the disciplinary map and a firm basis on which future research into disciplinary differences can build. Moreover, the quantitative instrument itself can be adopted or adapted in new studies, further enabling cumulative knowledge-building. Given these substantive, methodological and theoretical gains, it is perhaps surprising there exists any temptation to skip past discussion of mixed-methods research. This reflects the methodological character of the fields in which LCT emerged. We thus begin by briefly illustrating how the sociological frameworks on which the theory builds have become distanced from quantitative methods.

A methodological divide

A qualitative lack of the quantitative

In educational research the binary constellations of 'quantitative' and 'qualitative' are often associated with the influences of psychology and sociology. Approaches inspired (often unconsciously or at third hand) by psychology or aspiring to the appellation of 'sciences' have often favoured the quantitative and portrayed the qualitative as 'soft' and subjective (Moss *et al.* 2009). Conversely, among sociological approaches the quantitative has come to be negatively viewed and the qualitative valorized. The 'new sociology of education' of the early 1970s, for example, declared existing work to be old, positivist and conservative, and in its place announced a new, constructivist and critical field (Moore 2009). Among the stances constellated and renounced as 'old' were quantitative methods, in contrast to the association of 'critical', 'new' or even 'sociological' with qualitative methods. Accordingly, despite numerous theoretical differences, studies using Gramsci, Foucault, Deleuze, Butler and many other thinkers have overwhelmingly addressed the qualitative and neglected if not denigrated the quantitative.

Tellingly, this methodological sectarianism holds even for sociological approaches whose key protagonists were not antipathetic to quantitative methods. The frameworks on which LCT most directly builds are Pierre Bourdieu's 'field theory' and Basil Bernstein's 'code theory' (Maton 2014b; Chapter 1, this volume). Both theorists embraced methodological pluralism. Bourdieu employed quantitative approaches, especially multiple correspondence analysis; indeed, it is often referred to as 'Bourdieu's statistical method' (LeRoux and Rouanet 2010: 4). As Bourdieu stated, to 'think in terms of

field is to *think relationally*' and correspondence analysis 'is a technique which "thinks" in terms of relation' (Bourdieu and Wacquant 1992: 96; original emphasis). At the same time, Bourdieu's studies are replete with qualitative data, including ethnographic observation, interview quotes and discourse analysis. For Bourdieu, 'field theory' was most effectively conducted through a continuous interplay between quantitative and qualitative data in mixed-methods research (Bourdieu *et al.* 1963). Similarly, Bernstein described his framework as 'capable of exploration by diverse methods at the empirical level' (1977: 112) and employed statistical methods in his often overlooked *Volume II* collection of studies (1973). In describing his methodology, Bernstein emphasized the role of 'principles of description' whereby a model can engage with something beyond itself (see Chapter 2, this volume), adding that some 'principles may be quantitative whilst others are qualitative' (2000: 126). Bernstein (1977: 148) also critiqued assumptions underlying the dominant picture of methodologies, highlighting the invasive and invisible nature of qualitative methods in comparison to the privacy afforded by and visible criteria of quantitative methods.

In short, the principal architects of field theory and code theory cut across the binary constellations of methodology that dominate research into education and society. Yet, there remains a disjunction between this methodological pluralism and the majority of empirical research employing their frameworks. Most studies utilizing Bourdieu's concepts have adopted a wholly qualitative approach.[1] Moreover, this methodological choice is typically made without discussion – it goes without saying. This is particularly the case for studies using individual concepts, such as 'habitus' or 'cultural capital', decontextualized from Bourdieu's wider framework, indicating perhaps that, when not thinking in terms of 'field', methods appropriate to thinking relationally do not come to mind. Similarly, studies using Bernstein's theory have been predominantly qualitative. This is not simply a lack of statistics but rather a matter of relations between theory and data: the 'principles of description' advocated by Bernstein remain restricted to the qualitative. Where quantitative data are cited they typically represent demographic information for selecting participants for further (qualitative) study, freestanding statistics whose meanings are interpreted in terms of separate concepts, or qualitative data that have been quantified to enable counting of occurrences.[2] Quantitative data thereby remain distanced from theory. For example, studies may include means for translating between concepts and *qualitative* data which is then quantified for frequency analysis (e.g. Morais *et al.* 2004) but not for directly relating theory to quantitative data.

Qualitative and *quantitative*

As yet, the possibilities afforded by quantitative methodology remain underutilized by field theory and code theory, reflecting the sociology of education more generally. As Chapter 1 (this volume) describes, LCT enables false

dichotomies to be denied, including a forced choice between methodologies. To quote Bourdieu's exhortation, LCT enables researchers 'to mobilize all the techniques that are relevant and practically usable, given the definition of the object and the practical conditions of data collection' (Bourdieu and Wacquant 1992: 227). In this chapter we illustrate how research enacting LCT is taking advantage of the affordances of both qualitative and quantitative methods. In doing so, we show how LCT also reconfigures dichotomies of theory/data and researcher/researched. First, the studies we discuss bring theory and quantitative data into closer relations. Rather than simply using theory to *interpret* separate statistical data, we explore how concepts can be enacted within an instrument to *generate* statistical data. This is to embed concepts *within* quantitative methods, bringing theory into the heart of data collection. Second, where typically the researcher has employed concepts to interpret data concerning the practices or beliefs of others, the quantitative instrument additionally enables the researched to demonstrate the organizing principles of their practices or beliefs through the choices they make.

Specifically, we describe the creation and evolution within research projects of a quantitative instrument for embedding concepts in questionnaires. The projects comprise studies of, first, the unpopularity of music as a qualification in secondary schooling and, second, the differential integration of information and communication technologies across the secondary school curriculum. These studies differ in terms of problems (subject choice and technology integration), topics (music and educational technology) and geographic locations (UK and Australia). However, the projects are connected: the final version of the instrument developed in the music studies (2004–2005) formed the basis for its first iteration in the major studies of educational technology (2010–2013). They thus offer a cumulative account of methodological development.

Chapter 2 (this volume) highlights the significance of dialogue between theory and data. Mixed-methods research additionally requires dialogue between the data generated by quantitative and qualitative methods. Both projects employed documentary analysis and qualitative methods alongside the quantitative instrument. Thus, its development through these studies was stimulated from three principal directions: the evolving theoretical framework of LCT, the quantitative data generated by the instrument, and complementary data generated by qualitative methods. These stimulants overlap with three challenges for methodological development: theoretical fidelity, reliability, and validity. In short, the story of the instrument's evolution is one of numerous, recurrent and iterative adjustments to its form and content that aim at creating a tool consistent with the conceptual framework, reliable enough to generate dependable results, and sufficiently valid to ensure those results accurately reflect its object of study. Moreover, these challenges are themselves embedded in the aim of addressing tangible problems – the value of the instrument is its contribution to explanatory power. These aims serve as touchstones through our account.

Creating a quantitative instrument

Unpopular music

The studies that occasioned the creation of the instrument addressed school music and specifically its low take-up rate as a qualification in England. Existing research showed that music is popular with primary and secondary school students until, in year 9 (age 14), they have the option of selecting subject areas for examinations at GCSE level (to be completed by the end of year 11). At that point, uptake of study for the qualification is low. At the inception of these studies, 7 per cent of students chose music, considerably lower than comparable subjects, such as 38 per cent for art and design and 15 per cent for drama (Lamont *et al.* 2003). Existing explanations of this phenomenon remained undertheorized, piecemeal and ad hoc and research neglected the potential role played by the knowledge practices of school music (Lamont and Maton 2008).

In this context Alexandra Lamont (Keele University, UK) and Karl Maton undertook a series of studies in 2004–2005 aimed at exploring the organizing principles underlying knowledge practices in school music and their role in shaping its low uptake. These studies drew on Specialization, the most developed dimension of LCT at the time (e.g. Maton 2000a, 2000b, 2004). Specifically, they enacted *specialization codes*, comprising modalities of strengths of *epistemic relations* (ER) between knowledge practices and their proclaimed objects of study, and *social relations* (SR) between knowledge practices and their actors, authors or subjects (see Chapter 1, this volume). Practices may more strongly (+) or weakly (–) emphasize each relation and these two strengths give four principal *specialization codes* (Figure 1.2, page 12). Put simply, these declare that legitimacy depends on what you know and how (*knowledge codes*; ER+, SR–), who you are (*knower codes*; ER–, SR+), both specialist knowledge and knower attributes (*élite codes*; ER+, SR+), and neither (*relativist codes*; ER–, SR–).

In three iterative studies Lamont and Maton explored the specialization codes underlying:

1 definitions of achievement in curriculum documents and syllabi;
2 school students' perceptions of self-ability in, the significance of, and the basis of achievement in a range of academic subjects including music; and
3 perceptions of university students of the significance of, and basis for success in a range of subjects.

The research design was sequential exploratory mixed-methods, including documentary analysis, questionnaires and focus groups. Some results were discussed in Lamont and Maton (2008, 2010) and Maton (2006, 2007, 2014b: 75–85). Here we summarize relevant issues for the creation of the quantitative instrument.

The first study analysed policy and curriculum documents for the period 2000–2005: National Curriculum attainment targets and programmes of study for primary school and secondary school, GCSE syllabi of major examination boards, and Qualifications and Curriculum Authority criteria for GCSE examinations. The analysis generated a translation device (see Chapter 2, this volume) for revealing the four principal specialization codes in curriculum documents (Lamont and Maton 2008: 273). Simply put, documents were analysed in terms of whether they foregrounded as the basis of achievement: skills, procedures, techniques and knowledge (*epistemic relations*); and/or dispositions of learners, such as aptitude, attitude and personal expression (*social relations*). In summary, the analysis suggested the basis of achievement in school music underwent two main 'code shifts' (Maton 2014b: 77). From being dominated by a *knower code* in primary schooling (such as emphasizing personal expression), school music shifted first to a *knowledge code* in the early years of secondary schooling (emphasizing musical skills and knowledge) and then to an *élite code* in studying for GCSE examinations in later secondary schooling (requiring both technical skills and personal expression). Document analyses thereby generated the hypothesis that one reason for low uptake of school music qualifications may be that GCSE syllabi and examinations are characterized by an élite code: success requires both musical skills and musical dispositions, both knowledge and 'talent'.

In analysing curricular discourse this first study is not atypical. Research using social realist approaches has tended in recent years to focus more on knowledge than knowers (Maton 2014b). However, LCT emphasizes the problem-situation as a key driver of research. The issue animating the music studies concerned the subject choices of school students, highlighting the significance of views of knowers. Thus, the next step was to explore student perceptions. In sociology this would often be addressed through such qualitative methods as interviews and focus groups (which were utilized in the third study; see below) rather than the quantitative methods associated with psychology. However, as Chapter 5 (this volume) highlights, the capacity of LCT to be enacted in interdisciplinary contexts can perturb the taken-for-granted, opening up obscured possibilities. In this case, the research involved scholars from psychology and sociology and utilized both kinds of methods, raising the issue of how the concepts could be translated into a questionnaire item.

A first attempt and lessons learned

The second study comprised a questionnaire completed by 912 students from years 4 ($n=163$), 5 ($n=180$), 7 ($n=292$) and 9 ($n=277$) of four schools in England (Lamont and Maton 2008). The questionnaire included three questions about five school subjects (English, History, mathematics, music, and science) that asked students: how important it is to be good at

the subject; how they rate themselves at the subject; and what makes someone good at the subject. The last question represented the first attempt to translate LCT concepts into a quantitative instrument and is our focus here. The question offered a forced-choice of one of four options:

> [A] Anyone can do it, nothing special is needed.
> [B] You need to learn special skills or knowledge.
> [C] You need to have 'natural ability' or a 'feel' for it.
> [D] Only people with 'natural ability' can learn the special skills needed.

As Lamont and Maton (2008: 275) put it, 'we believed [these] might capture relativist, knowledge, knower and élite codes, respectively'. However, they immediately add: 'Henceforth, we refer to these as options (e.g. "knowledge option") rather than as codes' (2008: 276). We return to what prompted this change of terminology shortly.

In summary, the modal response for all students for music was the knowledge option B, echoing the knowledge code of secondary school curriculum revealed by the first study. Nonetheless, results suggested that 'the longer pupils are at school and the closer they are to GCSE (and, in particular, to taking GCSE music), the greater the likelihood that they will choose the élite option for music' (Lamont and Maton 2008: 276). There was a significant increase through years of schooling in the proportion of students choosing the élite option D: 7.5 per cent in year 6, 11.6 per cent in year 7, and 18.8 per cent in year 9, compared to a maximum of 3.6% for other subjects in year 9. Among students who had chosen to study GCSE music, this figure rose to 35 per cent. Results generated by the questionnaire thereby offered tentative support to the conjecture of the first study.

Crucially, the questionnaire item embraced a larger population of respondents than typically possible using qualitative methods, providing a more robust basis for conjectures concerning specialization codes. It also allowed a range of age groups to be analysed, providing insights into changing perceptions of subject areas as students progress through the curriculum. These attributes chime with the gaze embodied by LCT: to think in terms of legitimation codes is to think temporally – the issue of change over time is always in play. Further, the compact nature of the item (taking up little space in a questionnaire) afforded the possibility of asking students about a range of subject areas, enabling comparative analysis. This also resonates with the gaze embodied by LCT: to think in terms of legitimation codes is to think relationally. All positions in the planes are relational; all strengths are relative to other possibilities. In this case, the specialization code characterizing a specific subject area comprises strengths of epistemic relations and social relations (ER+/–, SR+/–) relative to those of other subject areas. Analysing a range of subjects allows for comparison, enabling these strengths to be established.

Lessons learned from theory and data

However, this first attempt was flawed. Both data and theory 'spoke back' to the instrument, highlighting limitations. Findings raised such questions as why music was not decisively viewed as an élite option by year 9 and why English and History were viewed as requiring 'nothing special', a finding incommensurate with conventional portraits of the subjects. The theory highlighted that while compact questionnaire items might *enable* relational analysis, the instrument itself did not yet *embody* relational thinking. Maton (2007) highlights several key issues raised from both directions. First, the wording of options was problematic. The knower option C offered only 'natural ability' or 'feel', reflecting the obsession of existing studies of music with genius and natural talent. This neglects notions of cultivated judgement found in discussions of humanities subjects such as English and History, potentially accounting for their 'relativist' results. Thus, the item did not embrace a sufficiently broad conception of possible realizations of social relations. Second, the élite option D included unnecessary priority by making 'natural ability' the prerequisite for 'special skills' rather than bringing together equal emphases on dispositions and knowledge. This formulation was theoretically unfounded and potentially lowered respondent numbers for that option, thereby affecting results for music.

Third, and most significantly, in offering a forced-choice the instrument design failed to enact a realist and relational gaze. The four options were originally intended to operationalize four specialization codes. However, they could not, which was the reason for Lamont and Maton (2008) changing their description from 'codes' to 'options'. Such a categorical scale design suits ideal types comprising discrete empirical characteristics. However, specialization codes are not ideal types. They conceptualize organizing principles: strengths of epistemic relations and social relations, where the strength of each relation for specific stances is relative to the strengths of that relation for other stances. Put another way, any specific position in the *specialization plane* (Figure 1.2, page 12) involves a strength of epistemic relations located along its continuum (y-axis) and a strength of social relations located along its continuum (the x-axis). Together, these two locations generate the position in the plane and thus the code. Therefore, to enact the concepts one should begin not with the codes but with the two relations whose relative strengths generate the codes. By offering four discrete boxes of empirical features the forced-choice design failed to capture the constitutive relations that generate specialization codes and the relational nature of those codes. A more continuous scaling approach was required that addressed the two relations separately.

This lesson has wider import than a questionnaire item. By trying to directly operationalize the four codes the study had begun from the wrong place in the framework. Qualitative methods, whether in observation protocols or interview questions, can succumb to the same reductionism. This

temptation to 'shortcut' to codes can also be felt when analysing data, generating erroneous readings. For example, describing one practice as a 'knowledge code' and another whose epistemic relations are weaker as a 'knower code' may seem intuitively correct, but upon closer inspection they could be found to exhibit the same code; they may simply occupy different positions within that code's quadrant of the specialization plane. This tendency towards seeing all differences in strengths of epistemic relations or social relations as categorical code shifts can be avoided by focusing on those relations. Such a focus aids *relational* and *topological* thinking, emphasizing the *relative* nature of strengths. To exemplify the case just given, consider natural science and psychology in Figure 3.2 (further below): psychology exhibits weaker epistemic relations than natural science but these are still relatively strong in relation to most other practices. This lesson also highlights the dialogic nature of relations between theory and the instrument: addressing problems raised by this first attempt underscored the significance of conceiving specialization codes topologically, bringing features of the theory into sharper relief.

A reconfigured instrument

A revised version of the instrument was enacted in a third, mixed-methods study of the perceptions of students who had already made a series of subject choices. The study comprised two parts: a questionnaire survey of 93 first-year university students and six focus groups with 20 students, both exploring their conceptions of six subject areas (English literature, History, mathematics, music, natural science, and psychology). As shown in Figure 3.1, the revised instrument comprised the question 'In your opinion, how important are these things for being good at [subject area]?' and three four-point Likert scales.

In Figure 3.1 epistemic relations are addressed by the 'skills' scale and social relations are addressed by the 'talent' and 'taste' scales. The latter aimed at exploring the notion of a cultivated gaze as the basis of achievement ('taste, judgement or a developed "feel"'). The division of 'talent' and 'taste' into separate scales was driven both by pragmatic considerations (concision of the items) and by theory (they equate to two sub-dimensions of social relations: *subjective relations* and *interactional relations*, respectively; see further below).

In your opinion, how important are these things for being good at [the subject]?

	Not at all	Not very	Quite	Very
Skills, techniques and specialist knowledge	☐	☐	☐	☐
Natural-born talent	☐	☐	☐	☐
Taste, judgement or a developed 'feel' for it	☐	☐	☐	☐

Figure 3.1 Scaled quantitative instrument from music studies.

Originally, findings were presented as a bar chart (Maton 2007: 102). For this chapter we have replotted results on a specialization plane as Figure 3.2. Questionnaire responses were numerically coded from 1 for 'Not at all' to 4 for 'Very'. The mean of the 'skills' item is used to calculate epistemic relations, ER = ∑a. The combined means of 'talent' and 'taste' items provide the social relations, SR = ∑b + c/2. Mean scores were calculated for each of the six subject areas. A grand mean, averaging all six subject areas, was then calculated for the *x*-axis (SR) and *y*-axis (ER). For each subject area, X and Y plots were determined by subtracting individual subject area ER and SR means from the grand means. The X and Y plots for each subject area identify their location on the specialization plane.

Figure 3.2 shows that responses characterized psychology and natural science as knowledge codes, English literature as a knower code, History as a relativist code, mathematics as close to the centre of the plane, and music as an élite code. These findings were triangulated with data from focus groups with university students that provided more insights into the reasoning and experiences behind these perceptions. The findings provided further

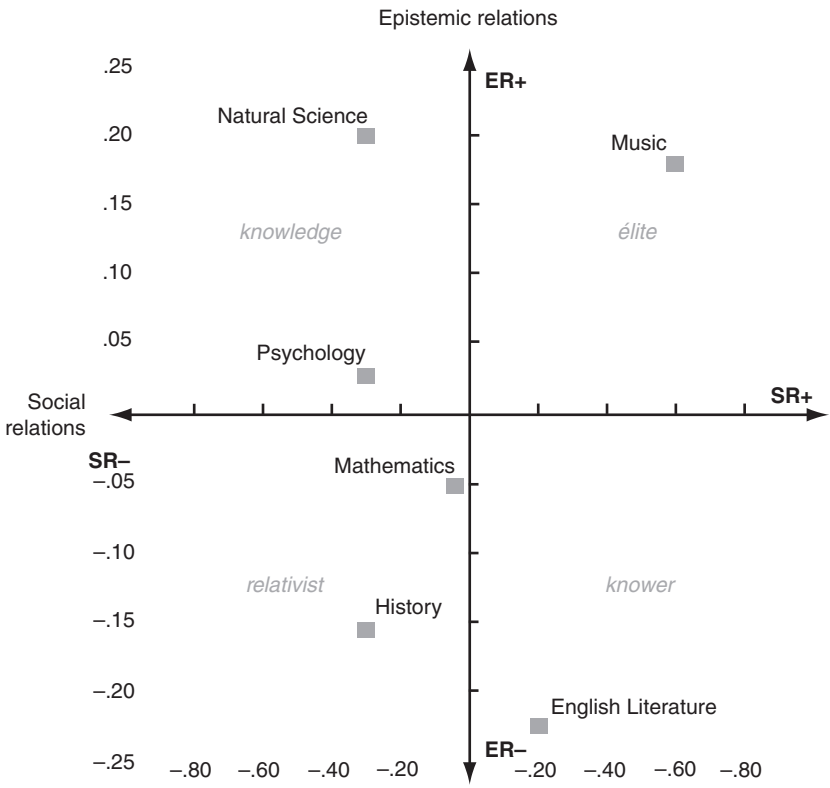

Figure 3.2 University students' perceptions of bases of achievement.

support for the conjecture that music at higher levels of secondary schooling (which respondents had very recently completed) is characterized by an élite code and that this code is unusual for subjects at this level. Moreover, other questionnaire findings and focus group data (Maton 2007) highlighted that, while music involves two measures of success (musical knowledge and musical dispositions), students viewed themselves as less capable in music and music itself as less significant than other subject areas. In short, music was perceived as more demanding and offering less potential gains than other subjects – a relatively unattractive subject choice.

In terms of the instrument, the findings suggested, first, that adding 'taste' and 'judgement' helped capture the cultivated knower code held by advocates to characterize study of English literature (Maton 2014b), though not yet that associated with History (e.g. Martin *et al.* 2010). Second, they highlighted the instrument's greater capacity to capture nuanced differences among subjects, such as between the knowledge codes of psychology and natural science, in which the latter involves considerably stronger epistemic relations (see Figure 3.2). Third, delineating scales for epistemic relations and social relations separately enabled the emphasis on both relations in music (élite code) to become clearly evident. Nonetheless, the results still posed challenges to the instrument, such as the uncertain position of mathematics. Methodologically, the next task was to explore how the instrument might fare in studies of larger and more diverse populations and for different problem-situations. This stage of evolution took place in the largest research project yet conducted in code theory.

Evolving the instrument

Educational technology integration

The studies which developed the quantitative instrument addressed technology in secondary education and specifically its differential integration across the curriculum. Existing research has shown that, in some cases, proliferation of information and communication technologies (ICTs) has been accompanied by integration within classroom practices, but that this is highly variable and inconsistent (Perrotta 2013). In particular, studies highlight significant variation across the curriculum – degree and form of technology usage depend on subject area (Howard *et al.* 2015). Yet, existing research has neglected the role played by differences in the knowledge practices of academic subjects (Howard and Maton 2011).

In this context of knowledge-blindness, Sarah Howard undertook a four-year, mixed-method, longitudinal series of studies during 2010–2013. These studies explored the organizing principles underlying knowledge practices across the secondary school curriculum and their role in shaping differential integration of educational technology. The research was embedded within a wider-ranging evaluation of how a major federal policy, the

'Digital Education Revolution', was enacted in the state of New South Wales, Australia. This initiative comprised a state-wide one-to-one laptop programme, the largest of its kind, in which all students in government schools were provided with their own specialist educational laptop computer in year 9 to keep until year 12. The full design and results of annual evaluations are reported in Howard and Mozejko (2013). Here we focus on how these studies helped advance the quantitative instrument.

In each year of the research, Howard utilized qualitative and quantitative methods in three phases:

1 analyses of state-level documents and videos relating to policy and curriculum;
2 online questionnaires of teachers, students and parents that explored ICT access, capabilities, beliefs about their use in teaching and learning, conceptions of learning outcomes when using ICTs, and (for teachers and students) bases of achievement in technology and a range of academic subjects; and
3 case studies of five schools that explored emergent findings from phase 2 in greater depth, including 7–8 teachers and 7–8 students at each school and involving interviews, focus groups, and documentary analysis of school policy and curriculum.

The resulting data set is substantial. For example, phase 2 online questionnaires involved over 600 secondary schools and responses from up to 25,000 secondary teachers and up to 89,000 students each year. All three phases were designed around the concepts of specialization codes: versions of the quantitative instrument were included in all teacher and student questionnaires and adapted for interviews and focus groups.

Annual policy analyses (phase 1) explored intended outcomes of the Digital Education Revolution. Nationally, a principal aim was to 'enable school users to discover, access and share collaborative education materials and information' (DEEWR 2008). In New South Wales, the laptop programme was viewed by the state education department as enabling a fundamental change in classroom practice, one encouraged through its provision of online support materials, such as teacher training videos. Analyses of policy documents and videos identified this desired change as embodying a code shift 'from an instructivist emphasis on knowledge to a constructivist emphasis on the knower' (Howard and Maton 2011: 200). Teachers were urged to no longer focus on the 'transmission of knowledge' and instead become 'co-constructors of learning', ICTs were presented as enabling students' personal creativity and expression, and teachers were expected to adopt practices associated with student-centred learning. These encouraged changes, emphasized throughout the lifetime of the policy, did not differentiate among subject areas. In short, knower-code practices were expected to be implemented across the curriculum as

a consequence of the programme. Such expectations are not unusual: the field of educational technology research is dominated by the association of ICTs with constructivist or 'student-centred' approaches (Howard and Maton 2011).

Building on existing studies using LCT, Howard conjectured that the specialization codes dominating academic subjects may differentially shape both how technology was integrated and resultant pedagogic outcomes. Simply put, the desired policy outcomes of knower-code practices were more likely to be enacted in subjects dominated by a knower code and less likely in those dominated by other codes. Accordingly, phases 2 and 3 analysed the practices and beliefs of teachers and students, as well as school and state curriculum, to determine the specialization codes characterizing seven academic subjects and thus code matches or clashes with the policy aims.[3]

In terms of the quantitative instrument, these studies involved different populations of respondents to previous research. As Chapter 2 (this volume) emphasizes, new problem-situations may require fresh means of translating between code concepts and the specificities of objects of study. Accordingly, the instrument was developed in response to findings from each annual study. A series of changes were made to the wording and structure of the questionnaire item to create a more sensitive and robust instrument. Qualitative versions enacted in interviews and focus groups were updated to match these changes to the quantitative instrument, enabling triangulation and dialogue between these forms of data. We shall discuss these iterative changes in terms of: first, developing reliability, to attain an instrument that generated consistent and dependable results about this object of study; and, second, improving validity, to ensure those results accurately reflected the 'realities' and intentions, so to speak, of respondents. We shall also draw out the wider lessons these developments offer for the craft of enacting LCT concepts in research.

Developing reliability

To build on existing findings, the research began from the most recent iteration of the quantitative instrument from the music studies (Figure 3.1, above). The three Likert scales were retained with two minor revisions of wording to accommodate a younger population of school students. Nuanced words ('specialist', 'techniques' and 'judgement') were removed or replaced ('taste' with 'experience') for accessibility and appropriate 'action' words ('learning', 'having', 'getting') added to emphasize foci. The resulting item is illustrated in Figure 3.3. This version was answered by 43,657 respondents (39,012 students and 4,663 teachers). Full results are reported in Howard and Carceller (2011). For brevity, we shall here illustrate our discussion with analyses of teacher surveys for three subject areas – English, science, and mathematics – that between them exemplify key issues driving the instrument's evolution.

How important are the following things for being good at English?

	Not at all	Not very	Quite	Very
Having natural talent at English	☐	☐	☐	☐
Learning knowledge and skills in English	☐	☐	☐	☐
Getting experience or a 'feel' for English	☐	☐	☐	☐

Figure 3.3 Example of 2010 instrument (student survey) from technology studies.

In the 2010 study, 80.2 per cent of the 4,663 teachers who participated in data collection responded to the item ($n = 3{,}740$). Such a large data set (and student responses were considerably more numerous) lent itself to statistical testing of the instrument using well-established quantitative techniques. Analysis of findings demonstrated that the three scales addressed the same overarching issue rather than disparate topics and were not overlapping in their focus. In statistical terms, variables were significantly correlated ($r < .401$, $p < .001$) and confirmatory factor analysis showed the three items load as one component, $\chi^2(3,\ N = 3685) = 1513.84$, $p < .001$. Simply put, the general focus of the instrument was sound. However, its reliability was less satisfactory. A standard measure (Cohen's alpha) revealed lower reliability (.56) than generally accepted as a benchmark (.7); i.e. if this data collection had been repeated there was only a 56 per cent likelihood of attaining the same results. Quantitative tests thus showed this version to be insufficiently reliable for generating dependable findings about this population of respondents. As emphasized above, each problem-situation may require its own means of enacting concepts; for this object of study, the instrument needed development.

Potential causes of such low reliability are manifold. A common reason can be providing insufficient opportunities for gathering data on a specific issue. The instrument attempted to capture epistemic relations in one scale ('knowledge and skills') and social relations in two scales ('natural talent' and 'experience or a "feel" for…'). This allowed each question to be extremely compact, so more questions could be included in a survey (capturing a greater range of academic subjects) and the survey length minimized (increasing the likelihood of completion). As discussed earlier, such concision enables the relational thinking central to enacting LCT. However, it also raises the pressure on each point of data collection to accurately capture its target information. Here, greatest pressure lay on the single scale for epistemic relations, which the developing theory also suggested was not enough.

LCT is a dynamic framework in productive dialogue with research. The development of the '4–K model' of Specialization (Maton 2014b: 171–95) in response to issues raised by substantive studies highlighted that epistemic

relations and social relations are more complex than might appear. The 4–K model distinguishes social relations into *subjective relations* that specialize kinds of knowers and *interactional relations* that specialize ways of knowing by actors. The realizations of these relations as teaching and learning practices in secondary schooling were expressed by the quantitative instrument as separate scales addressing 'natural talent' (for subjective relations) and 'experience or a "feel" for [the subject]' (for interactional relations). Similarly, the model distinguishes epistemic relations into *ontic relations* that specialize the known and *discursive relations* that specialize the discursive practices whereby it is known. However, the instrument collapsed pedagogic realizations of these two relations into one scale, as 'knowledge and skills'. Thus, it only partially grasped the complexity highlighted by the 4–K model, potentially undermining its reliability. To improve sensitivity and create more balance within the instrument a second line exploring epistemic relations was added to create two scales that addressed 'knowledge' and 'skills' separately. (Refining these measures would become an issue for validity, to which we return below.)

A second common reason for low reliability concerns wording – the meaning of an item may not be interpreted consistently. Triangulation with interview data suggested that 'experience' (see Figure 3.3) was understood differently by teachers across the curriculum. For example, mathematics teachers typically construed 'experience' as embodied by repeated practice at mathematical procedures – practical application of mathematical principles. Thus, what was intended to explore social relations across the disciplinary map was understood by some respondents as expressing epistemic relations. This issue has wider import for research. It is easy to assume the meanings of non-technical words are widely shared. This illusion of transparency highlights the significance of testing the validity of wording (which we discuss below), whether for questionnaires or qualitative interviews. Here, to avoid confusion and increase sensitivity of the scale, the term 'procedures' was added alongside 'skills' to the new 'epistemic relation' scale, and the 'social relation' scale for 'experience' was reworded to foreground the notion of 'getting a "feel" for' the subject area.

The instrument was thus extended from three to four scales and reworded, as illustrated by Figure 3.4. This form was used in 2011 and 2012. In the 2011 study 4,227 teachers participated in data collection, 83.5 per cent

How important are the following things to do well in the subject you primarily teach?

	Not at all	Not very	Quite	Very
Having natural talent at your subject area	☐	☐	☐	☐
Learning knowledge in your subject area	☐	☐	☐	☐
Learning skills and procedures in your subject area	☐	☐	☐	☐
Getting a 'feel' for your subject area through experience	☐	☐	☐	☐

Figure 3.4 Example of 2011 instrument (teacher survey) from technology studies.

responding to the item ($n=3{,}529$); in 2012, 2,806 teachers participated and 84.0 per cent responded ($n=2{,}355$). Analysis of the findings showed that the new instrument addressed the same overarching issue and scales were not overlapping. Statistically put, variables were significantly correlated in both years (2011, $r<.486$, $p<.001$; 2012, $r<.515$, $p<.001$) and confirmatory factor analysis indicated the four items loaded as one component: 2011, $\chi^2(6, N=3529)=4827.62$, $p<.001$; 2012, $\chi^2(6, N=2355)=3293.86$, $p<.001$. This time, though, reliability improved significantly to an acceptable level (alpha = .71). In short, thanks to dialogues with both theory and qualitative data the quantitative instrument was now suitably reliable. This was not, however, the end of the story.

Improving validity

Achieving reliability meant the instrument now generated consistent findings but not that those findings were faithful to the object of study. Indeed, the specialization codes suggested by the quantitative data contradicted those revealed by qualitative data. For example, analyses of interviews, focus groups and curriculum documents in the phase 3 case studies of New South Wales secondary schools showed mathematics to be characterized by a knowledge code and English as dominated by a knower code but including knowledge-code activities, such as learning technical skills (structuring texts, spelling, grammar, etc.) required for composition (Howard and Maton 2011). In contrast, quantitative analyses described both subjects as élite codes. Given the questions employed in qualitative data collection mirrored the quantitative instrument, something was awry. However, integrating the methods in research helps achieve fidelity to an object of study by enabling triangulation of data. The quantitative instrument helped shape the focus of qualitative methods and, in turn, qualitative findings helped reshape the quantitative instrument. Here interview data highlighted and helped resolve a problem of validity concerning 'epistemic relations'.

As discussed earlier, the instrument had been restructured to address two kinds of epistemic relations highlighted by the '4–K' model: *ontic relations* to that which is known and *discursive relations* to discursive practices whereby it is known. In Maton (2014b: 175–84) these concepts are introduced in analyses of intellectual fields, where ontic relations describe how knowledge practices emphasize legitimate objects of study and discursive relations describe how knowledge practices emphasize legitimate procedures for constructing objects of study. However, how code concepts are realized depends on what one is analysing. They thus require translation to explore the beliefs of secondary school teachers and students concerning bases of achievement in subject areas.

The first attempt at this translation for the technology studies comprised scales for 'knowledge' (ontic relations) and 'skills' (discursive relations). However, qualitative data suggested this was flawed. In interviews teachers

were asked to discuss 'skills' and 'knowledge' in their subject area. The term 'skills' was consistently used to refer to discursive practices students must enact to demonstrate successful mastery of a knowledge domain, such as expression and comprehension skills in English, measuring and graphing in science, and using fractions and decimals to solve mathematical problems. In this object of study, 'skills and procedures' consistently captured issues highlighted by discursive relations. In contrast, 'knowledge' was employed more fluidly by teachers to refer to specific content, a process of understanding, application of content, and students' dispositions for acquiring content and skills, among other meanings. Not only was 'knowledge' construed in diverse ways, these included forms of knowing associated with social relations rather than epistemic relations. The scale was thus potentially compromising validity of the instrument.

This offers lessons for all forms of research. As with 'experience' earlier above, it is tempting to assume meanings of words are transparent and shared among participants. Part of the craft of LCT is maintaining scepticism about what Bourdieu *et al.* (1991) called 'preconstructed' notions whose meanings appear self-evident. This often includes words central to the practices of a social field, such as 'teaching', 'learning' and 'knowledge' in education. (See Chapter 4, this volume, for examples from the field of design.) In this case, 'knowledge' could refer to objectified forms that realize epistemic relations or to mental processes of knowing that realize social relations (cf. Maton 2014b). For research practice wording matters – 'knowledge' is not self-evident. To resolve this general issue Bourdieu emphasized vigilance. As discussed in Chapter 1 (this volume), LCT additionally suggests a gaze can be converted into theory or, in this case, methodology. Here, vigilance can be supplemented by validity testing. In these studies, participants were asked in interviews and focus groups to discuss what they understood by key terms used in the instrument. Moreover, the qualitative data also provided a corpus within which the context revealed associated meanings. This helped reveal not only the problem but also a solution. Teachers across the curriculum consistently used 'content knowledge' in interviews to refer to that which students must demonstrably know for success, such as quotes from texts in English, chemical reactions in science, and ratios in mathematics. This connotation was particularly consistent when associated with terms such as 'concepts' and 'theory', suggesting a cluster of terms that realize discursive relations in a more valid manner for this population of respondents. Accordingly, the instrument was amended by replacing the term 'knowledge' with 'content knowledge, theory and concepts'.

The resultant questionnaire items are illustrated by Figure 3.5. This form was used in the 2013 study, in which 2,776 teachers participated, 85.4 per cent responding to the item ($n = 2{,}373$). The revised instrument remained robust. Confirmatory factor analysis indicated that items loaded as one component: $\chi^2(6,\ N = 2373) = 2676.77$, $p < .001$. Reliability of the measure was

How important are the following things to do well in the subject you primarily teach?

	Not at all	Not very	Quite	Very
Having natural talent at your subject area	☐	☐	☐	☐
Learning content knowledge, theory and concepts in your subject area	☐	☐	☐	☐
Learning skills and procedures in your subject area	☐	☐	☐	☐
Getting a 'feel' for your subject area through experience	☐	☐	☐	☐

Figure 3.5 Example of 2013 instrument (teacher survey) from technology studies.

also appropriate (alpha = .7). Now, though, the instrument also exhibited validity: responses were in tune with the findings of qualitative and documentary analyses.

Code clashes, code matches, and technology integration

Having achieved theoretical fidelity, reliability and validity, we can now return to the impetus for refining the instrument – differential technology integration across the curriculum – to illustrate the power of mixed-methods research. As discussed earlier, the use of digital technologies in the laptop programme was expected to shift teaching and learning across the secondary curriculum towards knower-code practices. The instrument established the specialization codes of seven subjects which, triangulated with findings from case studies, were related to quantitative and qualitative data on a range of beliefs and practices among teachers and students concerning the use of technology in classrooms.

Here we can but touch on results (see Howard *et al.* 2015). Continuing our illustrative focus, a total of 933 teachers of English ($n = 335$), mathematics ($n = 296$) and science ($n = 300$) responded to the item in 2013. Responses are plotted on the specialization plane of Figure 3.6: English exhibits a knower code, mathematics realizes a knowledge code, and science represents a relativist code. Crucially, the beliefs and practices of teachers concerning digital technologies reflected relations between the specialization codes of the laptop programme and their subject. English teachers demonstrated significantly more agreement ($M = 2.54$, $SD = .74$) than mathematics teachers ($M = 2.32$, $SD = .59$) with the belief that ICTs support positive student learning outcomes ($p < .001$). English teachers also reported more use of laptops in classroom practices ($M = 5.71$, $SD = 2.94$) than mathematics teachers ($M = 5.03$, $SD = 3.05$; $p < .05$). Moreover, English teachers reported more of a shift towards 'student-centred' practices ($M = 2.79$, $SD = .80$) than mathematics teachers ($M = 2.53$, $SD = .68$; $p < .001$). In sum, the knower-code subject of English dovetailed with the aims of the laptop programme more closely than did the knowledge-code subject of mathematics.

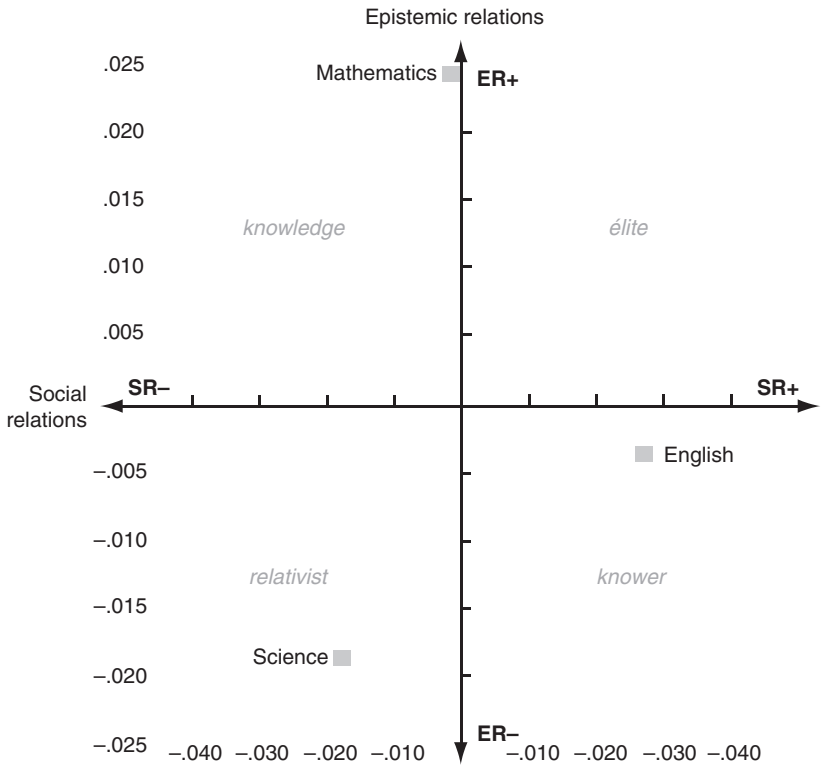

Figure 3.6 Specialization codes of English, mathematics and science – 2013 teacher survey.

This code match/clash was also reflected in how technology was used. Relating qualitative findings to specialization codes established by the instrument helped explain practices resulting from the policy. For example, mathematics teachers judged technology's usefulness in terms of teaching and learning mathematical knowledge, skills and procedures (emphasizing epistemic relations) and viewed uses typically constructed as expressing learners' creative dispositions as inessential (downplaying social relations). Accordingly, they often adapted the technology in knowledge-code ways, such as using visualization software originally designed for student-centred practices for 'traditional' teaching of skills such as graphing. In contrast, English teachers used laptops for the kinds of knower-code practices, such as creative writing and creating movies, envisaged by the policy. However, technology use reflected not each academic subject *tout court* but rather the specialization codes of practices comprising that subject. While the instrument revealed English to be dominated by a knower code, the subject also includes knowledge-code practices, such as structuring texts, grammar

and spelling. For these skills, teachers stated that ICTs were of limited value and even deleterious, such as encouraging students to neglect grammar and spelling. This suggests a future direction for research: using the instrument to explore the constitutive practices of academic subjects. It also illustrates the value of a mixed-methods approach: having established a subject's *dominant* code with the quantitative instrument, qualitative methods provided insight into the diversity of practices comprising the subject. Together, they revealed that teachers engaged with knower-code technology practices where these served knower-code pedagogic purposes but viewed them as less valuable for teaching and learning knowledge-code practices. Thus, different patterns of integration of technology among and within academic subjects reflected their specialization codes.

The findings also revealed an unanticipated twist. Though science is typically portrayed as a knowledge code (Maton 2014b), findings generated by the instrument characterized the construction of science *in secondary schooling in New South Wales* as a relativist code, a result affirmed by documentary analyses of curriculum and qualitative data from interviews. This helps explain an otherwise anomalous engagement with the laptop programme. Science teachers believed in the capacity of ICTs to support positive student learning outcomes as strongly as English teachers ($p = 1.00$) and reported even greater usage of laptops in classroom practice ($p = 1.00$). Their patterns of usage were also far more diverse than other teachers. Where the principles of selection, adaptation and enactment of technology by mathematics teachers were guided by the stronger epistemic relations of its knowledge code (ER+, SR–) and those of English teachers by the stronger social relations of its knower code (ER–, SR+), for science teachers the weaker epistemic relations and social relations of its relativist code (ER–, SR–) appeared to create a vacuum such that the use of technology was less systematically principled. This conjecture requires further research. Nonetheless, it illustrates how the quantitative instrument contributed to not only exploring this problem-situation but also revealing the unexpected, generating further questions.

Conclusion

An image of methodologies as binary constellations dominates social science. By enabling concepts to be embedded in both quantitative and qualitative methods, LCT defies this false dichotomy. Research can thereby take advantage of the affordances of both methodologies. This creates more than the sum of its parts: complementary methods contribute not only to explanatory power but also to developing each other. As we discussed, the quantitative instrument both shaped qualitative methods and was shaped by the data they generated. Our account also reveals the falsity of the portrait of quantitative methods as neat, linear and semi-mechanical that accompanies their disavowal by sociological approaches. As part of mixed-methods

research, the evolution of a quantitative instrument can be as complex, iterative, and involved as qualitative analysis. Whatever the methodology, developing theoretically-appropriate, reliable and valid research tools is a craft requiring judgement, dialogue, and immersion in the object of study. Nonetheless, such hard work offers substantive and theoretical rewards.

Substantively, the studies illustrate how quantitative data – triangulated with qualitative data and tested for validity and reliability – provide a robust basis for describing the organizing principles of knowledge practices. We can rely on more than intuition, commonsense, or singular examples when conjecturing that, for example, in secondary school English is likely to be characterized as a knower code or mathematics is likely to exhibit a knowledge code. We can now refer to reliable and valid analyses of an enormous data set. Of course, nothing is definitive – our use of 'likely' is significant. The technology studies do not conceptualize the specialization code of subject areas always and everywhere. We have repeatedly emphasized the specificities of objects of study – thus our use of italics in describing science in *New South Wales secondary schooling* as a relativist code. However, accepting such caveats, the size, scope and detailed triangulation of the data set generated by the technology studies represents an unprecedented basis for considering disciplinary differences, as well as the specific issue of differential technology integration. Future research, whether qualitative, quantitative or mixed-methods, need not start from scratch but instead can begin from the findings of these studies, enabling cumulative knowledge-building about substantive issues.

Theoretically, developing an instrument for enacting LCT concepts in quantitative analysis both augments the framework's capacity to engage with objects of study and provides a way for data to 'speak back' to the framework. Developing the instrument shed fresh light on the theory, such as the significance of relational and topological thinking and the value of foregrounding the constitutive relations of codes when conducting analysis. As we emphasized, the instrument itself also evolves in relation to the specificities of each problem-situation, such as differences among populations of respondents. This may require significant development but, crucially, such development need not start from scratch. New studies of different issues can adopt or adapt the existing instrument, enabling cumulative knowledge-building of the framework. For example, in a study discussed in Chapter 4 (this volume), Carvalho (2010) used the instrument to explore the specialization codes characterizing fields of design. In the research we discussed, the final iteration of the instrument developed by the music studies provided the basis for the first version used in the technology studies. The baton was passed on, the instrument further evolved.

Naturally, this is not the end of the story – answers to questions beget new questions. Methodologically, the instrument was designed to explore actors' perceptions of academic subjects; analyses of actors' practices (producing 'new' knowledge, constructing curriculum, teaching, learning, etc.)

are likely to require different phrasings of the questionnaire item. The studies above focused on perceptions of each subject as a whole – studies of their constitutive practices would provide a more fine-tuned understanding of the diverse codes at play in each field. Moreover, other dimensions of LCT await. For example, quantitative instruments enacting the concepts of 'semantic gravity' and semantic density' would provide powerful complements to qualitative tools that are being developed (see Chapter 1, this volume). Nonetheless, the specialization instrument represents a significant first step towards realizing the potential offered by transcending the methodological divide.

Notes

1 Notable exceptions include Grenfell and Hardy (2007) and studies collected in Robson and Sanders (2009) and Grenfell and Lebaron (2014).
2 For example, in volumes arising from the International Basil Bernstein Symposia (Morais *et al.* 2001; Muller *et al.* 2004; Moore *et al.* 2006; Singh *et al.* 2010; Ivinson *et al.* 2011), only eight of 67 papers involve any quantitative data and of the eight, seven embody the uses listed here; the eighth (Maton 2006) introduces the instrument discussed in this chapter.
3 Respondents were asked about academic subjects of which they had direct experience. Student surveys explored the specialization codes of seven subjects: mathematics, English, science, History, geography, music, and visual arts. Teacher surveys explored the specialization codes of using technology and the subject area in which each respondent principally taught.

References

Adorno, T. W. (1998) *Aesthetic Theory*, Minnesota: University of Minnesota Press.

Allen, I. E. and Seaman, J. (2010) *Learning on Demand: Online education in the United States*, Babson Survey Research Group and The Sloan Consortium. Online. Available HTTP: http://files.eric.ed.gov/fulltext/ED529931.pdf.

Archer, M. S. (1995) *Realist Social Theory: The morphogenetic approach*, Cambridge: Cambridge University Press.

Atkinson, R. K., Renkl, A. and Merrill, M. M. (2003) 'Transitioning from studying examples to solving problems: Effects of self-explanation prompts and fading worked-out steps', *Journal of Educational Psychology* 95(4): 774–83.

Australia Education International (2012) *International Student Numbers 2011*. Online. Available at: https://aei.gov.au/research/Research-Snapshots/Pages/default.aspx.

Bacot, J.-P. (2007) *Les sociétés fraternelles. Une histoire globale*, Paris: Dervy.

Barnett, M. (2006) 'Vocational knowledge and vocational pedagogy', in M. F. D. Young and J. Gamble (eds) *Knowledge, Curriculum and Qualifications for South African Further Education*, Pretoria: Human Resources Research Council Press.

Barnett, R. and Coate, K. (2005) *Engaging the Curriculum in Higher Education*, London: SRHE/OUP.

Bednarek, M. and J. R. Martin (2010) (eds) *New Discourse on Language: Functional perspectives on multimodality, identity and affiliation*, London: Continuum.

Bernstein, B. (1971) *Class, Codes and Control, Volume I: Theoretical studies towards a sociology of language*, London: Routledge and Kegan Paul.

Bernstein, B. (ed.) (1973) *Class, Codes and Control, Volume II: Applied studies towards a sociology of language*, London: Routledge and Kegan Paul.

Bernstein, B. (1977) *Class, Codes and Control, Volume III: Towards a theory of educational transmissions*, second edition, London: Routledge and Kegan Paul.

Bernstein, B. (1990) *Class, Codes and Control, Volume IV: The structuring of pedagogic discourse*, London: Routledge.

Bernstein, B. (1995) 'A response', in A. R. Sadovnik (ed.) *Knowledge and Pedagogy: The sociology of Basil Bernstein*, Norwood, NJ: Ablex.

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

Berry, J. W. (2005) 'Acculturation: Living successfully in two cultures', *International Journal of Intercultural Relations*, 29: 697–712.

Berteaux, R. (1996) *La symbolique au grade d'Apprenti*, Paris: Edimaf.

Berthelot, J.-M. (1997) *L'Intelligence du social*, Paris: PUF.

Bhaskar, R. (1975) *A Realist Theory of Science*, London: Verso.
Bhaskar, R. and Danermark, B. (2006) 'Metatheory, interdisciplinarity and disability research: A critical realist perspective', *Scandinavian Journal of Disability Research* 8(4): 278–97.
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.
Blommaert, J. (2009) 'Ethnography and democracy: Hymes' political theory of democracy', *Talk and Text* 29(3): 257–76.
Bohlman, P. V. (1997) 'Ontologies of music', in N. Cook and M. Everist (eds) *Rethinking Music*, Oxford: Oxford University Press.
Boudreaux, A. and Campbell, C. (2012) 'Student understanding of liquid-vapor phase equilibrium', *Journal of Chemical Education* 89(6): 707–14.
Boulton-Lewis, G. (1994) 'Tertiary students' knowledge of their own learning and a SOLO taxonomy', *Higher Education* 28(3): 387–402.
Bourdieu, P. (1994) *In Other Words*, Cambridge: Polity Press.
Bourdieu, P. (1996) *The Rules of Art*, Cambridge: Polity.
Bourdieu, P. (2004) *Science of Science and Reflexivity*, Cambridge: Polity.
Bourdieu, P. and Wacquant, L. J. D. (1992) *An Invitation to Reflexive Sociology*, Cambridge: Polity Press.
Bourdieu, P., Darbel, A., Rivet, J.-P. and Seibel, C. (1963) *Travail et travailleurs en Algérie*, Paris: Mouton.
Bourdieu, P., Chamboredon, J.-C. and Passeron, J.-C. (1991) *The Craft of Sociology: Epistemological preliminaries*, Berlin: Walter de Gruyter.
Brandt, C. B. (2008) 'Discursive geographies in science: Space, identity, and scientific discourse among indigenous women in higher education', *Cultural Studies of Science Education* 3: 703–30.
Brannen, J. (2005) 'Mixing methods: The entry of qualitative and quantitative approaches into the research process', *International Journal of Social Research Methodology* 8(3): 173–84.
Brown, A. (1999) 'Parental participation, positioning and pedagogy: A sociological study of the IMPACT primary school mathematics project', *Collected Original Resources in Education* 24(3): 7/A02–11/C09.
Brown, A. (2006) 'Languages of description and the education of researchers', in R. Moore, M. Arnot, J. Beck and H. Daniels (eds) *Knowledge, Power and Educational Reform*, London: Routledge.
Carey, S. (1985) *Conceptual Change in Childhood*, Cambridge, MA: MIT Press.
Carvalho, L. (2010) 'A sociology of informal learning in/about design', unpublished PhD thesis, University of Sydney, Australia. Online. Available at: www.legitimationcodetheory.com.
Carvalho, L. and Dong, A. (2007) 'Knowledge and identity in the design field', in R. Zehner and C. Reidsema (eds) *Proceedings of ConnectED International Conference on Design Education*, ISBN 978–00646–48147–0.
Carvalho, L. and Goodyear, P. (2014) 'Analysing the structuring of knowledge in learning networks', in S. Bayne, C. Jones, M. de Laat, T. Ryberg and C. Sinclair (eds) *Proceedings of the 9th International Conference on Networked Learning 2014*, ISBN 978–1–86220–304–4.
Carvalho, L., Dong, A. and Maton, K. (2009) 'Legitimating design: A sociology of knowledge account of the field', *Design Studies* 30(5): 483–502.

Chang, Y. H., Chang, C. Y. and Tseng, Y. H. (2010) 'Trends of science education research: An automatic content analysis', *Journal of Science Education and Technology* 19(4): 315–31.

Chen, R. T.-H. (2010) 'Knowledge and knowers in online learning: Investigating the effects of online flexible learning on student sojourner', unpublished PhD thesis, University of Wollongong, Australia. Online. Available at: www.legitimationcodetheory.com.

Chen, R. T.-H., Bennett, S. and Maton, K. (2008) 'The adaptation of Chinese international students to online flexible learning: Two case studies', *Distance Education* 29(3): 307–23.

Chen, R. T.-H., Maton, K. and Bennett, S. (2011) 'Absenting discipline: Constructivist approaches in online learning', in F. Christie and K. Maton (eds) *Disciplinarity*, London: Continuum.

Chi, M. T. H., Feltovich, P. J. and Glaser, R. (1981) 'Categorization and representation of physics problems by experts and novices', *Cognitive Science* 5(2): 121–52.

Christie, F. (2002) *Classroom Discourse: A functional perspective*, London: Continuum.

Christie, F. (2012) *Language Education through the School Years: A functional perspective*, Michigan: Wiley-Blackwell.

Christie, F. and Cléirigh, C. (2008) 'On the importance of "showing"', in C. Wu, C. M. I. M. Matthiessen and M. Herke (eds) *Voices Around the World: Proceedings of the 35th International Systemic Functional Linguistics Congress*, Macquarie University, Sydney: ISFC35 Committee, 13–18.

Christie, F. and Derewianka, B. (2008) *School Discourse: Learning to write across the years of schooling*, London: Continuum.

Christie, F. and Macken-Horarik, M. (2009) 'Building verticality in subject English', in F. Christie and J. R. Martin (eds) *Language, Knowledge and Pedagogy*, London: Continuum.

Christie, F. and Macken-Horarik, M. (2011) 'Disciplinarity and school subject English', in F. Christie and K. Maton (eds) *Disciplinarity*, 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. (2014) 'Enabling cumulative knowledge-building through teaching: A Legitimation Code Theory analysis of pedagogic practice in law and political science', unpublished PhD thesis, Rhodes University, South Africa. Online. Available at: www.legitimationcodetheory.com.

Clark, R. and Mayer, R. (2011) *E-Learning and the Science of Instruction: Proven guidelines for consumers and designers of multimedia learning*, third edition, San Francisco, CA: Pfeiffer.

Conan Doyle, Sir A. (1892/1981) *The Adventures of Sherlock Holmes*, London: Penguin.

Cross, N. (2004) 'Expertise in design: An overview' *Design Studies*, 25: 427–41.

Cummings, K. (2013) 'A community-based report of the developmental history of PER', paper presented at the American Association of Physics Teachers, Portland, Oregon.

DEEWR (Department of Education Employment and Workplace Relations) (2008) *Digital Education Revolution*. Online. Available at: www.deewr.gov.au/Schooling/DigitalEducationRevolution/Pages/default.aspx.

diSessa, A. A. (1993) 'Toward an epistemology of physics', *Cognition and Instruction*, 10(2/3): 105–225.

diSessa, A. A., Gillespie, N. and Esterly, J. (2004) 'Coherence versus fragmentation in the development of the concept of force', *Cognitive Science* 28: 843–900.

Dixon, M. and Simpson, D. (2011) *Cambridge Checkpoints 2001: HSC Standard English. Past Examination Questions and Responses*, Melbourne: Cambridge University Press.

Doherty, C. (2010) 'Doing business: Knowledges in the internationalised business lecture', *Higher Education Research and Development* 29(3): 245–58.

Dooley, K. T. (2001) 'Adapting to diversity: Pedagogy for Taiwanese students in mainstream Australian secondary school classes', unpublished PhD thesis, Griffith University, Australia.

Dorst, K. (2008) 'Design research: A revolution-waiting-to-happen', *Design Studies*, 29: 4–11.

Dreyfus, S. E. (2004) 'The five stage model of adult skill acquisition', *Bulletin of Science Technology & Society*, 24: 177–81.

Erduran, S. and Scerri, E. (2002) 'The nature of chemical knowledge and chemical education', in J. K. Gilbert, R. Justi, D. F. Treagust and J. H. Van Driel (eds) *Chemical Education*, London: Kluwer Academic.

Exley, B. (2005) 'Teachers' professional knowledge bases for offshore education: Two case studies of Western teachers working in Indonesia', unpublished PhD thesis, Queensland University of Technology, Australia.

Foucault, M. (1970) *The Order of Things*, London: Pantheon.

Friedman, K. (2003) 'Theory construction in design research: Criteria, approaches and methods', *Design Studies*, 24: 507–22.

Galceran, S. (2004) *Les franc-maçonneries*, Paris: La découverte.

Gallagher, M. K. (2011) 'In search of a theoretical basis for storytelling in education research: Story as method', *International Journal of Research & Method in Education*, 34(1): 49–61.

Geertz, C. (1973) *The Interpretation of Cultures*, New York: Basic Books.

Georgiou, H. (2009) 'An exploration of tertiary students' conceptions of familiar thermodynamic processes', unpublished Honours thesis, University of Sydney, Australia.

Georgiou, H. and Sharma, M. D. (2010) 'A report on a preliminary diagnostic for identifying thermal physics conceptions of tertiary students', *International Journal of Innovation in Science and Mathematics Education* 18(2): 32–51.

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.

Grenfell, M. J. (2012) (ed.) *Pierre Bourdieu: Key concepts*, revised edition, London: Acumen.

Grenfell, M. J. (2014) *Pierre Bourdieu*, London: Bloomsbury.

Grenfell, M. and Hardy, C. (2007) *Art Rules: Pierre Bourdieu and the visual arts*, Oxford: Berg.

Grenfell, M. and Lebaron, F. (2014) (eds) *Bourdieu and Data Analysis: Methodological principles and practices*, Oxford: Peter Lang.

Grize, J.-B. (1997) *Logique et langage*, Paris: Ophrys.

Grubb, N. (2006) 'Vocationalism and the differentiation of tertiary education: Lessons from US community colleges', *Journal of Further and Higher Education*, 30: 27–42.

Haines, J. (2008) 'The origins of the musical staff', *The Musical Quarterly* 91(3–4): 327–78.

Hake, R. R. (1998) 'Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses', *American Journal of Physics* 66(1): 64–74.

Halliday, M. A. K. (1985) 'Systemic background', in J. D. Benson and W. S. Greaves (eds) *Systemic Perspectives on Discourse, Volume 1*, Norwood, NJ: Ablex.

Halliday, M. A. K. and Matthiessen, C. M. M. (1999) *Construing Experience through Meaning*, London: Cassell.

Halliday, M. A. K. and Matthiessen, C. M. M. (2004) *An Introduction to Functional Grammar*, third edition, London: Edward Arnold.

Hammersley, M. (1992) 'Deconstructing the qualitative–quantitative divide', in J. Brannen (ed.) *Mixing Methods: Qualitative and quantitative research*, London: Avebury.

Hasan, R. (1984) 'The nursery tale as genre', *Nottingham Linguistics Circular* 13: 71–102.

Hasan, R. (2005) *Language, Society and Consciousness*, London: Equinox.

Hasan, R. (2009) *Semantic Variation: Meaning in society and in sociolinguistics*, London: Equinox.

Hay, C. (2014) 'Learning to inhabit the chair: Knowledge transfer in contemporary Australian director training' unpublished PhD thesis, University of Sydney, Australia. Online. Available at: www.legitimationcodetheory.com.

Hood, S. (2011) 'Writing discipline: Comparing inscriptions of knowledge and knowers in academic writing', in F. Christie and K. Maton (eds) *Disciplinarity*, London: Continuum.

Hornberger, N. H. (2009) 'Hymes's linguistics and ethnography in education', *Talk and Text* 29(3): 347–58.

Howard, S. K. and Carceller, C. (2011) *DER-NSW 2010: Implications of the 2010 data collection*, Sydney: New South Wales Department of Education and Communities.

Howard, S. K. and Maton, K. (2011) 'Theorising knowledge practices: A missing piece of the educational technology puzzle', *Research in Learning Technology* 19(3): 191–206.

Howard, S. K. and Mozejko, A. (2013) *DER-NSW Evaluation: Conclusions on student and teacher engagement and ICT use*, Sydney: New South Wales Department of Education and Communities.

Howard, S. K., Chan, A. and Caputi, P. (2015) 'More than beliefs: Subject-areas and teachers' integration of laptops in secondary teaching', *British Journal of Educational Technology*, 46(2): 360–9.

Howe, K. R. (1992) 'Getting over the quantitative–qualitative debate', *American Journal of Education* 100(2): 236–56.

Ivinson, G., Davies, B. and Fitz, J. (eds) (2011) *Knowledge and Identity: Concepts and applications in Bernstein's sociology*, London: Routledge.

Johnson, R. B. and Onwuegbuzie, A. J. (2004) 'Mixed methods research: A research paradigm whose time has come', *Educational Researcher* 33(7): 14–26.

Jordens, C. F. C. (2002) 'Reading spoken stories for values: A discursive study of cancer survivors and their professional carers', unpublished PhD thesis, University of Sydney, Australia.

Kant, I. (1781/2007) *Critique of Pure Reason*, London: Penguin.

Knight, N. K. (2010) 'Wrinkling complexity: Concepts of identity and affiliation in humour', in M. Bednarek and J. R. Martin (eds) *New Discourse on Language*, London: Continuum.

Labov, W. and Waletzky, J (1967) 'Narrative analysis: Oral versions of personal experience', in J. Helm (ed.) *Essays on the Verbal and Visual Arts*, Seattle: University of Washington Press.

Lamont, A. and Maton, K. (2008) 'Choosing music: Exploratory studies into the low uptake of music GCSE', *British Journal of Music Education* 25(3): 267–82.

Lamont, A. and Maton, K. (2010) 'Unpopular music: Beliefs and behaviours towards music in education', in R. Wright (ed.) *Sociology and Music Education*, London: Ashgate.

Lamont, A., Hargreaves, D. J., Marshall, N. A. and Tarrant, M. (2003) 'Young people's music in and out of school', *British Journal of Music Education* 20(3): 1–13.

Larkin, J., McDermott, J., Simon, D. P. and Simon, H. A. (1980) 'Expert and novice performance in solving physics problems', *Science* 208(4450): 1335–42.

Lawson, B. (2004) 'Schemata, gambits and precedents: Some factors in design expertise', *Design Studies* 25: 443–57.

LeRoux, B. and Rouanet, H. (2010) *Multiple Correspondence Analysis*, London: Sage.

Lin, H. S., Cheng, H. J. and Lawrenz, F. (2000) 'The assessment of student and teachers' understanding of gas laws', *Journal of Chemical Education* 77(2): 235–38.

Liu, X. F. (2001) 'Synthesizing research on student conceptions in science', *International Journal of Science Education* 23(1): 55–81.

Luckett, K. (2012) 'Disciplinarity in question: Comparing knowledge and knower codes in sociology', *Research Papers in Education* 27(1): 19–40.

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. L. (2013) 'On notes and knowers: The representation, evaluation and legitimation of jazz', unpublished PhD thesis, University of Adelaide, Australia. Online. Available HTTP: www.legitimationcodetheory.com.

Martin, J. R. (1992) *English Text: System and structure*, Amsterdam: John Benjamins.

Martin, J. R. (2000) 'Grammar meets genre: Reflections on the "Sydney School"', *Arts: The Journal of the Sydney University Arts Association* 22: 47–95.

Martin, J. R. (2007) 'Construing knowledge: A functional linguistic perspective', in F. Christie and J. R. Martin (eds) *Language, Knowledge and Pedagogy*, London: Continuum.

Martin, J. R. (2010) 'Semantic variation: Modelling system, text and affiliation in social semiosis', in M. Bednarek and J. R. Martin (eds) *New Discourse on Language*, London: Continuum.

Martin, J. R. (2011) 'Bridging troubled waters: Interdisciplinarity and what makes it stick', in F. Christie and K. Maton (eds) *Disciplinarity*, London: Continuum.

Martin, J. R. (2012) *Forensic Linguistics: Volume 8 in the collected works of J. R. Martin*, Shanghai: Shanghai Jiao Tong University Press.

Martin, J. R. (2013a) 'Embedded literacy: Knowledge as meaning', *Linguistics and Education* 24(1): 23–37.

Martin, J. R. (2013b) *Interviews with M. A. K. Halliday*, London: Bloomsbury.

Martin, J. R. (2015) 'Revisiting field: Specialized knowledge in Ancient History and Biology secondary school discourse', *Onomázein*.

Martin, J. R. and Maton, K. (2013) (eds) 'Special Issue: Cumulative Knowledge-Building in Secondary Schooling', *Linguistics and Education*, 24(1): 1–74.

Martin, J. R. and Matruglio, E. (2013) 'Revisiting mode: Context in/dependency in Ancient History classroom discourse', in Huang Guowen, Zhang Delu and Yang Xinzhang (eds) *Studies in Functional Linguistics and Discourse Analysis, Volume 5*, Beijing: Higher Education Press.

Martin, J. R. and Plum, G. A. (1997) 'Construing experience: Some story genres', in M. Bamberg (ed.) *Oral Versions of Personal Experience: Three decades of narrative analysis* 7(1–4): 299–308.

Martin, J. R. and Rose, D. (2007) *Working with Discourse: Meaning beyond the clause*, London: Continuum.

Martin, J. R. and Rose, D. (2008) *Genre Relations: Mapping culture*, London: Equinox.

Martin, J. R. and White, P. R. R. (2005) *The Language of Evaluation: Appraisal in English*, New York: Palgrave Macmillan.

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.

Martin, J. R., Zappavigna, M. and Dwyer, P. (2012) 'Beyond redemption: Choice and consequence in Youth Justice Conferencing', in F. Yan and J. J. Webster (eds) *Developing Systemic Functional Linguistics*, London: Equinox.

Marton, F. (1981) 'Phenomenography: Describing conceptions of the world around us', *Instructional Science* 10(2): 177–200.

Mason, A. and Singh, C. (2013) 'Using categorization task to improve expertise in introductory physics', paper presented at the Physics Education Research Conference, Portland, Oregon.

Maton, K. (2000a) 'Recovering pedagogic discourse: A Bernsteinian approach to the sociology of educational knowledge', *Linguistics and Education* 11(1): 79–98.

Maton, K. (2000b) 'Languages of legitimation: The structuring significance for intellectual fields of strategic knowledge claims', *British Journal of Sociology of Education* 21(2): 147–67.

Maton, K. (2003) 'Reflexivity, relationism and research: Pierre Bourdieu and the epistemic conditions of social scientific knowledge', *Space and Culture* 6(1): 52–65.

Maton, K. (2004) 'The wrong kind of knower: Education, expansion and the epistemic device', in J. Muller, B. Davies, and A. Morais (eds) *Reading Bernstein, Researching Bernstein*, London: RoutledgeFalmer.

Maton, K. (2005) 'A question of autonomy: Bourdieu's field approach and policy in higher education', *Journal of Education Policy* 20(6): 687–704.

Maton, K. (2006) 'On knowledge structures and knower structures', in R. Moore, M. Arnot, J. Beck and H. Daniels (eds) *Knowledge, Power and Educational Reform*, London: Routledge.

Maton, K. (2007) 'Knowledge-knower structures in intellectual and educational fields', in F. Christie and J. R. Martin (eds) *Language, Knowledge and Pedagogy*, London: Continuum.

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. (2010) 'Canons and progress in the arts and humanities: Knowers and gazes', in K. Maton and R. Moore (eds) *Social Realism, Knowledge and the Sociology of Education*, London: Continuum.

Maton, K. (2011) 'Theories and things: The Semantics of disciplinarity', in F. Christie and K. Maton (eds) *Disciplinarity*, London: Continuum.

Maton, K. (2012a) 'The next generation: Inter-disciplinary research into strange new worlds', paper presented at 39th International Systemic Functional Congress, Sydney. Online. Available at: www.legitimationcodetheory.com.

Maton, K. (2012b) 'Habitus', in M. Grenfell (ed.) *Pierre Bourdieu: Key concepts*, revised edition, London: Acumen.

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*, London: Palgrave Macmillan.

Maton, K. (2014b) *Knowledge and Knowers: Towards a realist sociology of education*, London: Routledge.

Maton, K. and Doran, Y. J. (2015a) 'Semantic density: A translation device for analyzing the complexity of knowledge practices through discourse, part 1 – wording', *Onomázein*.

Maton, K. and Doran, Y. J. (2015b) 'Condensation: A translation device for analyzing the complexity of knowledge practices through discourse, part 2 – clausing and sequencing', *Onomázein*.

Maton, K. and Doran, Y. J. (2016) 'SFL and code theory', in T. Bartlett and G. O'Grady (eds) *Routledge Systemic Functional Linguistic Handbook*, London: Routledge.

Maton, K. and Moore, R. (2010) (eds) *Social Realism, Knowledge and the Sociology of Education: Coalitions of the mind*, London: Continuum.

Maton, K. and Muller, J. (2007) 'A sociology for the transmission of knowledges', in F. Christie and J. R. Martin (eds) *Language, Knowledge and Pedagogy*, 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.

McDermott, L. C. (1990) 'A view from physics', in M. Gardener, G. Greeno, F. Reif, A. H. Schoenfeld, A. diSessa and E. Stage (eds) *Toward a Scientific Practice of Science Education*, Hillsdale, NJ: Laurence Erlbaum.

Meidell Sigsgaard, A.-V. (2013) 'Who knows what?: The teaching of knowledge and knowers in a fifth grade Danish as a second language classroom', unpublished PhD thesis, Aarhus University, Denmark. Online. Available at: www.legitimationcodetheory.com.

Meltzer, D. E. (2004) 'Investigation of students' reasoning regarding heat, work, and the first law of thermodynamics in an introductory calculus-based general physics course', *American Journal of Physics* 72(11): 1432–46.

Meltzer, D. E. (2005) 'Investigation of student reasoning regarding concepts in thermal physics', *American Physical Society Forum of Education Newsletter* (Spring). Online. Available at: www.aps.org/units/fed/newsletters/spring2005/investigation.html.

Minstrell, J. (2001) 'Facets of students' thinking: Designing to cross the gap from research to standards-based practice', in K. Crowley, C. D. Schunn and T. Okada (eds) *Designing for Science*, Mahwah, NJ: Lawrence Erlbaum Associates.

Molle, D. and Prior, P. (2008) 'Multimodal genre systems in EAP writing pedagogy: Reflecting on a needs analysis', *TESOL Quarterly* 42(4): 541–66.

Moore, R. (2009) *Towards the Sociology of Truth*, London: Continuum.

Moore, R. (2011) 'Making the break: Disciplines and interdisciplinarity', in F. Christie and K. Maton (eds) *Disciplinarity*, London: Continuum.

Moore, R. (2013) *Basil Bernstein: The thinker and the field*, London: Routledge.

Moore, R. and Maton, K. (2001) 'Founding the sociology of knowledge: Basil Bernstein, intellectual fields and the epistemic device', in A. Morais, I. Neves, B. Davies and H. Daniels (eds) *Towards a Sociology of Pedagogy*, New York: Peter Lang.

Moore, R. and Muller, J. (2002) 'The growth of knowledge and the discursive gap', *British Journal of Sociology of Education* 23(4): 627–38.

Moore, R., Arnot, M., Beck, J. and Daniels, H. (eds) (2006) *Knowledge, Power and Educational Reform: Applying the sociology of Basil Bernstein*, London: Routledge.

Morais, A., Neves, I., Davies, B. and Daniels, H. (eds) (2001) *Towards a Sociology of Pedagogy: The contribution of Basil Bernstein to research*, New York: Peter Lang.

Morais, A., Neves, I. and Pires, D. (2004) 'The what and the how of teaching and learning: Going deeper into sociological analysis and intervention', in J. Muller, B. Davies and A. Morais (eds) *Reading Bernstein, Researching Bernstein*, London: RoutledgeFalmer.

Morrow, W. (2009) *Bounds of Democracy: Epistemological access in higher education*, Cape Town: HSRC.

Moss, G. (2001) 'Bernstein's languages of description: Some generative principles', *International Journal of Social Research Methodology* 4(1): 17–19.

Moss, P. A., Phillips, D. C., Erickson, F. D., Floden, R. E., Lather, P. A. and Schneider, B. L. (2009) 'Learning from our differences: A dialogue across perspectives on quality in education research', *Educational Researcher* 38(7): 501–17.

Muller, J. (2007) 'Hierarchy, knowledge and the school curriculum', in F. Christie and J. R. Martin (eds) *Language, Knowledge and Pedagogy*, London: Continuum.

Muller, J., Davies, B. and Morais, A. (eds) (2004) *Reading Bernstein, Researching Bernstein*, London: Routledge.

Neves, I., Morais, A. and Afonso, M. (2004) 'Teacher training contexts: Study of specific sociological characteristics', in J. Muller, B. Davies and A. Morais (eds) *Reading Bernstein, Researching Bernstein*, London: RoutledgeFalmer.

New Zealand Qualifications Authority (2010) *Level 3 English Question Booklet*, Auckland: New Zealand Qualifications Authority.

NSW Board of Studies (2007) *English (Standard) Paper 2 (Modules), Help for HSC Students*, Sydney: New South Wales Board of Studies.

NSW Board of Studies (2015) *English Syllabus for the Higher School Certificate*, Online. Available at: www.boardofstudies.nsw.edu.au/syllabus_hsc/english-std-adv.html#syllabus.

O'Halloran, K. L. (2005) *Mathematical Discourse: Language, symbolism and visual images*, London: Continuum.

Otero, V. K. and Harlow, D. B. (2009) 'Getting started in qualitative physics education research', *Reviews in PER, 2*. Online. Available at: www.compadre.org/Repository/document/ServeFile.cfm?ID=9122&DocID=1218.

Paltridge, B., Starfield, S., Ravelli, L. and Nicholson, S. (2012) 'Doctoral writing in the visual and performing arts: Two ends of a continuum', *Studies in Higher Education* 37(8): 989–1003.

Perrotta, C. (2013) 'Do school-level factors influence the educational benefits of digital technology? A critical analysis of teachers' perceptions', *British Journal of Educational Technology* 44(2): 314–27.

Popper, K. (1963) *Conjectures and Refutations*, London: Routledge.

Poulet, C. (2010) 'Recognising and revealing knowers: An enhanced analysis of masonic recruitment and apprenticeship', *British Journal of Sociology of Education* 31(6): 777–96.

Powerhouse Museum (2015) About the Powerhouse Museum. Online. Available at: www.powerhousemuseum.com/about/.

Quinn, L. and Vorster, J. (2014) 'Isn't it time to start thinking about "developing" academic developers in a more systematic way?', *International Journal for Academic Development* 19(3): 255–8.

Ramognino, N. (2005) 'Du concept d'institution: La langue et l'école instituent un "monde commun"', in N. Ramognino and P. Verges (eds) *Le Français d'hier et d'aujourd'hui. Politiques de la langue et apprentissages scolaires*, Aix-en-Provence: Publications de l'Université de Provence.

Redish, E. F. (2004) 'A theoretical framework for physics education research: Modeling student thinking', in E. F. Redish and M. Vicentini (eds) *Proceedings of the International School of Physics, "Enrico Fermi" Course CLVI*, Amsterdam: IOS Press.

Redish, E. F. and Bing, T. J. (2009) 'Analyzing problem solving using math in physics: Epistemological framing via warrants', *Physical Review Special Topics – Physics Education Research* 5.

Rhodes, C. (2000) 'Ghostwriting research: Positioning the researcher in the interview text', *Qualitative Inquiry* 6(4): 511–25.

Robson, K. and Sanders, C. (2009) *Quantifying Theory: Pierre Bourdieu*, London: Springer.

Rose, D. and Martin, J. R. (2012) *Learning to Write, Reading to Learn: Genre, knowledge and pedagogy in the Sydney School*, London: Equinox.

Rothery, J. (1990) 'Story writing in primary school: Assessing narrative type genres', unpublished PhD thesis, University of Sydney, Australia.

Rothery, J. and Stenglin, M. (1997) 'Entertaining and instructing: Exploring experience through story, in F. Christie and J. R. Martin (eds) *Genres and Institutions*, London: Continuum.

Ryan, A. (2008) 'Indigenous knowledge in the science curriculum: Avoiding neocolonialism', *Cultural Studies of Science Education* 3: 663–702.

Sabella, M. and Redish, E. F. (2007) 'Knowledge activation and organization in physics problem-solving', *American Journal of Physics* 75(11): 1017–29.

Salomon, G. (1991) 'Transcending the qualitative–quantitative debate: The analytic and systemic approaches to educational research', *Educational Researcher* 20(6): 10–18.

Shaffer, S. and McDermott, L. C. (2005) 'A research-based approach to improving student understanding of the vector nature of kinematical concepts', *American Journal of Physics* 73: 921–31.

Schlunke, K. (2005) 'Gagging the past', *Journal of Media and Cultural Studies* 19(3): 413–19.

Schwab, J. (1962) 'The teaching of science as enquiry', in J. Schwab and P. Brandwein (eds) *The Teaching of Science*, Cambridge MA: Harvard University Press.

Selwyn, N. (2006) 'High-tech soc-of-ed? Signs of a "smart" sociology of education technology', *British Journal of Sociology of Education* 27(3): 417–26.

Selwyn, N. (2010) 'Looking beyond learning: Notes towards the critical study of educational technology', *Journal of Computer Assisted Learning* 26: 65–73.

Shalem, Y. and Slonimsky, L. (2010) 'Seeing epistemic order: Construction and transmission of evaluative criteria', *British Journal of Sociology of Education* 31(6): 755–78.

Sharma, M., Millar, R., Smith, A. and Sefton, I. M. (2004) 'Students' understandings of gravity in an orbiting space-ship', *Research in Science Education* 34(3): 267–89.

Shay, S. (2013) 'Conceptualizing curriculum differentiation in higher education: A sociology of knowledge point of view', *British Journal of Sociology of Education* 34(4): 563–82.

Simpson, J. S. (2010) '"I'm more afraid of you than I am of the terrorists": Agency, dissent, and the challenges of democratic hope', *Review of Education, Pedagogy and Cultural Studies* 32(2): 177–205.

Singh, P., Sadovnik, A. and Semel, S. (eds) (2010) *Toolkits, Translation Devices, Conceptual Tyrannies: Essays on Basil Bernstein's sociology of knowledge*, New York: Peter Lang.

Smith, D. (2005) *Institutional Ethnography: A sociology for people*, Oxford: AltaMira Press.

South African Department of Basic Education (2010) *National Senior Certificate English Home Language Paper 2*, Cape Town: Department of Basic Education.

Spector, J. M. (2013) 'Emerging educational technologies and research directions', *Journal of Educational Technology & Society* 16(2): 21–30.

Starfield, S., Paltridge, B. and Ravelli, L. J. (2012) '"Why do we have to write?": Practice-based theses in the visual and performing arts and the place of writing', in V. J. Bhatia and C. Berkenkotter (eds) *Insights into Academic Genres*, Bern: Peter Lang.

Stehr, N. (1994) *Knowledge Societies*, London: Sage.

Steyn, D. (2012) 'Conceptualising design knowledge and its recontextualization in the studiowork component of a design foundation curriculum', unpublished MPhil thesis, University of Cape Town.

Straehler-Pohl, H. and Gellert, U. (2013) 'Towards a Bernsteinian language of description for mathematics classroom discourse', *British Journal of Sociology of Education* 34(3): 313–32.

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.

Taguieff, P.-A. (2005) *La foire aux illuminés. Esotérisme, théorie du complot, extrémisme*, Paris: Fayard.

Taylor, P. and Bain, P. (2003) '"Subterranean worksick blues": Humour as subversion in two call centres', *Organization Studies* 24: 1487–509.

Thomson, E. A. (2014) *Battling with Words: A study of language, diversity and social inclusion in the Australian Department of Defence*, Canberra: Australian Government.

Todorov, T. (1984) *Mikhail Bakhtin: The dialogical principle*, Minnesota: The University of Minnesota Press.

Treagust, D. F. (1988) 'Development and use of diagnostic-tests to evaluate students' misconceptions in science', *International Journal of Science Education* 10(2): 159–69.

Tsai, C. C. and Wen, M. L. (2005) 'Research and trends in science education from 1998 to 2002: A content analysis of publication in selected journals', *International Journal of Science Education* 27(1): 3–14.

Van Krieken, R., Habibis, B., Smith, P., Hutchins, B., Martin, G. and Maton, K. (2014) *Sociology: Themes and perspectives*, fifth edition, Sydney: Pearson.

Van Leeuwen, T. (1999) *Speech, Music, Sound*, Basingstoke: Macmillan.

VanSlyke-Briggs, K. (2009) 'Consider ethnofiction', *Ethnography and Education* 4(3): 335–45.

Vidal Lizama, M. (2014) 'Theorising popular education as a knowledge practice: The case of Chile', unpublished PhD thesis, University of Technology, Sydney, Australia. Online. Available at: www.legitimationcodetheory.com.

Vosniadou, S. (2002) 'On the nature of naive physics', in M. Mason (ed.) *Reconsidering Conceptual Change*, Dordrecht: Kluwer Academic.

Vosniadou, S. (2008) *International Handbook of Research on Conceptual Change*, New York: Routledge.

Vosniadou, S. and Ortony, A. (1989) *Similarity and Analogical Reasoning*, Cambridge: Cambridge University Press.

Weekes, T. (2014) 'From dot points to disciplinarity: The theory and practice of disciplinary literacies in secondary schooling', unpublished PhD thesis, University of New England, Australia. Online. Available at: www.legitimationcodetheory.com.

Wheelahan, L. (2010) *Why Knowledge Matters in Curriculum: A social realist argument*, London: Routledge.

Wittgenstein, L. (1980) *Culture and Value*, Chicago: University of Chicago Press.

Wolf, M. (1992) *A Thrice Told Tale: Feminism, postmodernism and ethnographic responsibility*, Stanford, CA: Stanford University Press.

Wolf, S. F., Dougherty, D. P. and Kortemeyer, G. (2012) 'Rigging the deck: Selecting good problems for expert-novice card-sorting experiments', *Physical Review Special Topics-Physics Education Research* 8(2). Online. Available at: http://prst-per.aps.org/abstract/PRSTPER/v8/i2/e020116.

Wolfe, J. (2006) 'A musician's English: The challenge awaiting international students in tertiary music programs in Australia', *TESOL in Context* 16(1): 18–25.

Wolfe, J. (2007) '"You'll have to start early if you want to be on time for the F sharp!" Language and the study of music: Implications for international students studying in tertiary music programs in Australia', paper presented at ISANA International Conference, Adelaide, Australia.

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

Wu, H. K. (2009) 'Modelling a complex system: Using novice-expert analysis for developing an effective technology-enhanced learning environment', *International Journal of Science Education* 32(2): 195–219.

Young, M. F. D. (2008) *Bringing Knowledge Back In: From social constructivism to social realism*, London: Routledge.

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