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**Knowledge-based expertise as the hallmark of work of risk: an analysis of
the curriculum and pedagogy of a National Diploma in Train-Driving**

A minor dissertation submitted in partial fulfilment of the requirements for the degree of

MASTER OF PHILOSOPHY

Curriculum Development

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CTZGON001

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Declaration

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature:

February 2011

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Abstract

This study examines the suitability of competency-based modular education and training as preparation for skilled vocational work. In particular, it explores the nature of the curriculum and pedagogy that leads to the transmission and acquisition of risk work; defined as work that involves inherent unpredictability which depends on the skilled performance of the worker-practitioner.

A single qualitative case study of a national train driving diploma is examined. The study develops a conceptual framework of the nature of risk work and the pedagogic dimensions suitable to risk work through a review of literature that focuses on the unpredictable nature of risk work, the tacit dimensions of skilled work and the pedagogic practices of craft that enable the transmission of risk work. The conceptual framework develops the hypothesis that a curriculum and pedagogy that successfully transmits a capacity to handle risk must transmit a combination of the ability to make discretionary judgements as well as the ability to perform routinised action. The conceptual framework posits that this kind of capacity is grounded in an internally held competence; which concerns the ability to understand the relationships between the aspects that comprise work (the parts) and the purpose of the work (the whole). To explore the hypothesis, the structure of the curriculum and the evaluation practices of the train driving diploma are examined, using a coding device adapted from a Bernsteinian analysis of a craft apprenticeship.

The study finds that there are two competing forms of knowledge within in a single curriculum – a knowledge based on scientific principles and a procedural knowledge form. The former provides the basis for unpredictable risk assessment and the later for procedural rule following or routinised action. The problem in the curriculum studied, is that scientific knowledge is under-specified and not adequately provided, which leads to an over-emphasis on procedure and certainty rather than risk.

In conclusion the study develops a model of the pedagogic outcome of work of risk as a performance that involves both procedural expertise and discretionary judgement; based on an internally-held competence developed through the interplay of three knowledge types; scientific, procedural and tacit knowledge. The forms of knowledge are transmitted via a pedagogic mode that has both direct classroom instruction and modelling dimensions.

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Chapter 1: Introduction

1.1 Overview

This dissertation concerns the adoption of competency-based modular training (CBMT) in South African vocational curricula. In particular the dissertation examines the suitability of CBMT in skilled¹ vocational work.

The vocational education and training (VET) field in South African has undergone significant shifts in the past two decades through the adoption of the National Qualifications Framework and the National Skills Development Strategy; both state initiatives aimed at addressing skills shortages in the country. A key intention of shifts in the vocational education and training arena in South Africa (and globally) has been the creation of greater employment opportunities for young people through opening access to nationally registered vocational programmes (Altman, 2008; Nzimande, 2010; OECD, 2010). However, an important argument is made that there is no guarantee that young people are being provided with 'real' educational opportunities by merely opening access to educational institutions or formalised VET programmes (Wheelahan, 2010; Young 2010). The question needs to be asked, "access to what?" as it is argued that unless debates about access to education pose questions about knowledge and curriculum, learners will gain limited knowledge and educational access becomes "little more than 'warehousing' of young people" (Young, 2010:4). This dissertation contributes to the empirical body of work concerned with the vocational education and training curriculum - curriculum is the puzzle.

This chapter provides an overview of the purpose of the dissertation and discusses its context and rationale. It also outlines the structure the dissertation.

¹Skilled work is defined as work that involves complexity and operates above a matriculation level.

1.2 Purpose of the study

The purpose of the dissertation is to examine whether competency-based modular training (CBMT) is appropriate to skilled vocational work through a specific examination of the workings of a CBMT curriculum. In particular, the dissertation examines the suitability of the CBMT model currently used nationally to train train-drivers in South Africa.

In order to address the notion of skilled work, and the curriculum and pedagogy appropriate to preparation for such work, the dissertation focuses on risk work. A definition of risk work is provided in chapter 2, the conceptual framework of this study. Here it is sufficient to define risk work as any occupation that involves risk in the common sense use of the word, where actions can have dangerous consequences, as well as the understanding that risk work involves complexity. The research question is:

Which curriculum and pedagogy leads to the transmission² and acquisition of risk work?

1.3 The context and rationale of the study

1.3.1 The shift from apprenticeships to competency-based modular education and training

The historical context of this study concerns the shift in the South African VET field from an apprenticeship training model, which started in the South African Railways to a CBMT system. CBMT emerged in the late 1980s and gained prominence in the 1990s with the adoption of the South African National Qualifications Framework (Kraak, 2004, 2008; Akoojee and McGrath, 2005; Gamble, 2000, 2003, 2004). In broad terms this was a move from a knowledge-based to a standards-based vocational curriculum. The knowledge-based curriculum includes a knowledge or theoretical dimension acquired through instruction (usually at a technical college); while the standards-based vocational curriculum focuses on a set of competencies or standards that are required in workplace performance (Young, 2006; Gamble, 2003, 2006).

There are competing voices in the historical narratives about this shift. One argument is that the previous knowledge-based approach to VET failed because it was heavily 'theoretical' and not sufficiently linked to work. In this view, the decline of the South African apprenticeship system reflects global trends where the traditional apprenticeship model has been considered increasingly unsuitable to conditions of global competition (Gamble, 2001;

² The terms transmission and acquisition are used to indicate that which is both intentionally and *unintentionally* conveyed by the curriculum.

Unwin, Fuller, Turbin and Young, 2004, Young 2006; Illeris, 2003) and has been discontinued or substantially restructured³ - for example the modern apprenticeships in Britain (Ainley and Rainbird, 1999) and the learnership in South Africa.

The opposing view is that the standards-based approach fails because it does not sufficiently focus on knowledge or that it only values knowledge that can be stated explicitly according to a set of workplace competencies and hence is limited in its use beyond the context in which it is located (Barnett, 2006; Gamble, 2006; Young, 2006). It is argued that after more than ten years of implementation these standards-based programmes have not succeeded in providing young people with better employment prospects (Young, 2010).

Part of what separates these two positions is differing views about the kind of knowledge that is required in VET. Certainly, a distinctive feature of VET is that it is inescapably tied to the world of work and hence the vocational curriculum has the challenge of needing to relate to the practicalities of work, the particular knowledge requirements of a specific occupation, as well as the broader knowledge field (the discipline) out of which the occupation arises (Young, 2006; Barnett, 2006; Gamble 2006). It is recognised that any improvement in the vocational curriculum will in some way need to bring theory and practice closer together by having a curriculum that 'faces both ways' (Barnett, 2006), which in essence involves bringing together two distinct forms of curriculum. The unanswered question is how to accomplish this task. Thus the aim of this dissertation is to contribute to the debates on the improvement of vocational curricula, through developing a conceptual understanding of the kind of knowledge and curricula needed in skilled vocational work.

1.3.2 A critical appraisal of CBMT

As this dissertation explores the suitability of CBMT for vocational curricula, the features and critiques of CBMT as discussed in the literature are briefly presented.

The most salient feature of CBMT is that it is performance-based; the focus is on the end product of learning, the performance or demonstrable *competence*, as opposed to being concerned with the learning process itself (Jessup, 1989; Marginson, 1993; Allais, 2007; Emad and Roth, 2008; Leung, 2002). Another key dimension of CBMT is that it is assessment-led. Assessment is criterion-referenced; where the goal of assessment is to measure how well the individual has performed against standards specified in advance as

³ Other critiques of the apprenticeship model was the power relations inherent in many apprenticeships as well as the time-based nature of apprenticeships being nothing more than a wasteful exercise (Illeris, 2003; Turner in Ainley and Rainbird, 1999).

opposed to grading the individual with reference to others in a group (Kraak, 1999; Dunn, Parry and Morgan, 2002; Jessup, 1989). Explicitly stated competency statements lie at the heart of the model (Emad and Roth, 2008; Allais, 2007) and are intended to allow for public scrutiny and greater transparency in the assessment process (Cretchley and Castle, 1993; Ecclestone, 1999; Leung, 2002).

Various critiques of CBMT have been raised by writers in the fields of higher education, professional development and the VET field. The overriding theme in these critiques is that the behaviourist orientation of CBMT has reduced the complex nature of human learning and performance to isolated bits for the ease of measurement (Cretchley and Castle, 2001; Hyland, 1997; Kraak, 1999; Talbot, 2004). The assessment model relies on pre-determined competencies and hence knowledge that cannot be stipulated in advance is not valued, as the sole focus of teaching and learning activities is the performance criteria (Cretchley and Castle, 2001; Emad and Roth, 2008). Hence, the approach does not recognise the importance of content or disciplinary knowledge (Muller, 2002; Young, 2002, 2006, 2010; Wheelahan, 2007; Gamble, 2003). Another critique is that CBMT is epistemologically flawed as it assumes that disciplinary-knowledge and everyday knowledge (the required performance) can be integrated and tested 'once-and-for-all' (Allais, 2010). CBMT also fails to account for the tacit in learning (Ecclestone, 1999; Gamble, 2004). In addition, CBMT is seen to ignore the process of learning and the importance of both the curriculum and the teacher in the process (Muller 2002; Cretchley and Castle, 2001; Hyland 1996).

These critiques, and in particular the lack of attention to knowledge as an integral part of the curriculum, is of particular relevance in this study. This study questions whether a pedagogic model that relies on predictability can usefully contribute to learning in a complex and unpredictable environment.

1.4 Structure of dissertation

This chapter has outlined the purpose and rationale of the study.

Chapter 2, '*Conceptual framework – theorising the work of risk*'; develops the conceptual framework of the study. The nature of risk work is theorised and a craft model of curriculum is examined as a means to explore the pedagogic practice suitable to work of risk.

Chapter 3, '*Research methodology*'; describes the qualitative case study approach adopted in the study as well as the data collection and analysis strategy. The study is positioned within a social realist approach to education and the chapter provides a detailed account of the coding device used to analyse the knowledge and pedagogic practice of the training driving diploma.

Chapter 4, '*The Structure of the Curriculum*'; outlines the structure of the diploma and presents empirical data and analyses the classification of the curriculum and pedagogy of the diploma. The chapter concludes with a summary of how the diploma fits within Bernstein's theorisation of competence or performance pedagogic models.

Chapter 5, '*Evaluation Practices*'; presents empirical data and analyses the framing of the evaluative practices of the national diploma. The chapter concludes with an analysis of knowledge types prioritised in the diploma.

Chapter 6, '*Analysis and conclusion*'; presents the overall conclusions of the study and concludes with a conceptual model of the pedagogic outcome of work of risk, as the overall conceptual product of the dissertation.

1.5 List of conventions

- The term *craftsman* is used. This is historical in nature and no gender specificity (or discrimination) is intended.
- Many of the research participants were second language speakers. Speech idiosyncrasies are left in the quotes that are used as empirical data. Square brackets [...] are used to clarify or translate quotes.
- The term CBMT is used in this dissertation. There are terminological variations, for example Competency Based Training (CBT) and Competency Based Education and Training (CBET), which essentially refer to the same training approach.

Chapter 2: Conceptual Framework – theorising the work of risk

2.1 Overview

In this chapter three areas of literature are explored in order to put forward a conceptual framework that offers an account of the kind of curriculum and pedagogy required to prepare trainees for work in risk environments. The chapter first theorises the nature of risk work before turning to the issues of curriculum and pedagogy.

As seen in chapter 1 the vocational curriculum is always inescapably linked to work. It is for this reason that the starting point is a theorisation of the *nature of risk work* (Pye, 1968; Polanyi, 1958). Pye's work is used to introduce the understanding of risk work as a combination of 'work of risk' and 'work of certainty'. Polanyi's concepts of focal and subsidiary awareness are employed to show how risk and certainty interrelate.

Thereafter, Basil Bernstein's insight that pedagogic practice has either a performance or a competence outcome is discussed.

Finally, the conceptual framework focuses directly on the kind of curriculum and pedagogy most suitable to risk work. This section is informed by Gamble's (2004) empirical findings of a craft apprenticeship as work of risk.

2.2 The nature of 'work of risk'

2.2.1 *Workmanship of risk*⁴

Theory concerning work and risk is examined using Pye (1968). Although Pye's notions refer to craft, they are useful for my study as they offer insights into the nature of work that involves a complex integration of manual skills and knowledge, focused on a reduction of risk. Pye defines craftsmanship as "workmanship using any kind of technique or apparatus in which the quality of the result is not predetermined, but depends on the judgement, dexterity and care which the maker exercises" (1968:7). Pye argues that quality is always at risk

⁴ The notion of work of risk is a concept developed through a reading of Pye. I encountered Pye's work while conducting a close reading of Gamble's work and I use Pye's notion of risk as a central feature in my dissertation and hence offer a detailed definition of Pye's concepts of "workmanship of risk" and "workmanship of certainty" here (Pye, 1968:7).

during the production of an object because the quality depends on the skill of the craftsman and the work can be spoiled at any time. This work is what he refers to as “workmanship of risk” (7). Conversely, he defines “workmanship of certainty” (7) as work where the result is predetermined and unalterable; the kind of workmanship that is found in automated mass production. Essentially the difference between the two forms of workmanship relates to the degree to which the quality of the end-result is unfixed or undetermined.

The concepts of risk and certainty are always interrelated because craftsmen continually strive to reduce risk by introducing tools, techniques and habits into the production process which aim to increase certainty. However, the notion of risk work extends beyond craft and is inherent in all forms of skilled work ranging from train driving to medical surgery. Minimising risk through the introduction of tools or techniques can range from the simple example of using a ruler to draw a straight line to the use of a power tool by the dentist in a complex dental procedure.

Reformulating Pye’s concepts as ‘work of risk’ and ‘work of certainty’

This study recasts the terms ‘workmanship of risk’ and ‘workmanship of certainty’ as ‘work of risk’ and ‘work of certainty’, in order to broaden the application of Pye’s concepts to work which may not be craft. In developing a model of risk work, we need to understand the particular demands of train driving and the sort of “judgement, dexterity and care” required in ‘work of risk’ and in train driving more specifically (1968:7). We need to understand how risk and certainty interrelate in work of risk, such as train driving. To do this, the chapter now turns to Polanyi’s concepts of the relationship between “focal and subsidiary awareness”. This discussion illuminates how practices which introduce certainty come to be learned or established

2.2.2 Understanding the interrelation of risk and certainty

In his discussion of skilled practice, Polanyi (1958) distinguishes between *focal awareness* where attention is focussed on a salient aspect or relationship in an action, event or information; and *subsidiary awareness* which involves attention to other aspects of the performance. He illustrates this distinction by referring to the act of hammering a nail. The body is subsidiarily aware of the feeling of the hammer in the hand, but the person is focussed on the hammer hitting the nail. As Polanyi describes it “I have a *subsidiary awareness* of the feeling in the palm of my hand which is merged into my *focal awareness* of my driving in the nail” (1958:55, emphasis in the original). Polanyi relates the two kinds of awareness to being able to grasp the relation between wholes and parts. When focal awareness is on the whole, the parts are in subsidiary awareness. In Polanyi’s words “the

relationship of the particulars jointly forming the whole may be ineffable, even though all the parts are explicitly specifiable.” (1958:88) Returning to the analogy of the hammer; should something startling occur, such as the handle of the hammer breaks, the awareness will shift back to those aspects of which we were subsidiarily aware (the parts), and we may lose sense of the whole.

The relationship between these two forms of awareness leads Polanyi to a useful insight regarding how skilled practices become *embodied*. Polanyi argues that in coming to use a tool expertly, we shift our sense of the boundaries between ourselves and the tool (or, put more broadly, in coming to perform a skill we shift the boundary between ourselves and the practice). While we rely on a tool or a probe, these are not used as external objects:

We may test the tool for its effectiveness or the probe for its suitability, for example in discovering the hidden details of a cavity, but the tool and the probe can never lie in the field of these operations; they remain necessarily on our side of it, forming part of ourselves, the operating persons. We pour ourselves out into them and assimilate them as parts of our own existence. We accept them existentially by dwelling in them” (1958:59).

This shifting of the boundary between ourselves and the tool involves a focal awareness on the whole task and a subsidiary awareness on the parts comprising it, which develops over time and with practice.

The journey of becoming expert or master is, in some ways, about going from seeing a task in terms of its parts to understanding how the parts exist and relate together to form a whole. In discussing the nature of skills, Ainley summarises Polanyi as follows:

People do not acquire a skill just by learning to perform its fragments; they must also discover the knack of coordinating them effectively. This can be demonstrated and imitated but it cannot be taught or written down. It must be discovered by an intelligent effort of the learner to integrate the parts into a whole that is greater than the sum of its parts (1993:12-13).

Developing this kind of tacit knowing is thus about acts of *integration*, in which the person sees significance and meaning in information that might otherwise seem disparate and unrelated, even though the person may not be able to articulate the known relationships, or principles which served to integrate the parts. This means that in the earlier stages of learning, a part is seen as just that, but over time the significance of the part to the whole is appreciated. As this tacit knowing is developed a skill will come to feel as though it were something habitual or routinised.

What characterises this routinisation? Before the use of a tool can gather the quality of habit and before we can dwell in a tool (or a practice), we must go through a process in which the focal awareness is first on the parts (when it feels anything but habitual) and then later on an integrating awareness of the whole (as it becomes habitual). Routinisation thus involves performing a complex skill in such a way that its components no longer need to be held in focal awareness, but rather that the *aim* of the task is in focal awareness. Becoming familiar with a task in this way is not some kind of unthinking repetition: rather “it is a structural change achieved by a repeated mental effort aimed at the instrumentalization of certain things and actions in the service of some purpose” (Polanyi, 1958:62).

This discussion of routinisation is a point of intersection between Polanyi’s work and that of Pye. Ainley, discussing the work of Pye, notes that the development of these sort of routinised techniques and habits results in “a major economy of effort, so that the result is attained with the least possible physical exertion and so the conscious attention can be directed to what is essential and away from repetitive and routine operations that can be completed unconsciously” (1993:6). In Pye’s terms, routinisation can thus be understood as introducing certainty into ‘work of risk’ because the techniques and habits act like a craftsman’s tools, increasing certainty and allowing the person to focus on pressing salient aspects of the task.

In sum *the work of risk is theorised* as involving routinised action punctuated by moments of rapid decision making and action. Rapid decision-making is characterised by shifting attention to salient aspects of the work within an ongoing awareness of the overall purpose of the work. Routinised action introduces certainty into the work of risk, while moments of explicit attention and action (the decision making) refer to moments of increased complexity or change - that which cannot be predicted.

2.3 The curriculum and pedagogy of 'work of risk'

2.3.1 *Bernstein's performance and competence pedagogic models*

In seeking to analyse the curriculum and pedagogy of risk work this dissertation draws on the theory of Basil Bernstein (1996, 2000). Bernstein's framework has been used extensively in a number of studies examining the curriculum and pedagogic practices of the schooling sector, higher education and, more recently, vocational education and training⁵. This dissertation focuses on Bernstein's (1996, 2000) discussion of pedagogic practice. Bernstein argues that a pedagogic practice can have one of two possible outcomes – either a performance outcome or a competence outcome. In order to understand the two pedagogic outcomes it is necessary to briefly turn to Bernstein's analytical concepts of classification and framing.

Framing concerns the rules of production of a discourse / curriculum or the "inner logic of the pedagogic practice" (Bernstein, 2000:12). Framing is about the rules or controls of how the message can be communicated between the educator and the taught. Where framing is strong the educator has greater control and where framing is weaker the student has greater apparent control. In delineating what the educator and/or student controls Bernstein defines framing as the nature of control over: the selection of the communication; its sequencing (what comes first, what comes second); its pacing (the rate of expected acquisition); the criteria of evaluation; and the control over the social base which makes this transmission possible Bernstein (1975, 1996, 2000).

Classification concerns the structuring of the curriculum and is about the boundary strength, or degree of insulation, between categories or discourses. Strong classification refers to well insulated boundaries between categories and it is this insulation that maintains the unique character, voice and identity of the category. Weak classification involves boundaries between categories that are more diffuse and hence the degree of insulation is weakened. Weak classifications refer to less specialised discourses and identities (Bernstein, 1975, 1996, 2000).

A performance outcome, based on an explicit pedagogy, is characterised by strong classification and framing relations. Performance models emphasise outputs, the product or text which the learner is expected to construct. The distinguishing feature of performance models is that they are based on visible or explicit pedagogies. Explicit evaluation criteria are a key dimension of the pedagogic modality; according to Bernstein "criteria will be explicit

⁵ Examples of these studies are cited in chapter 3.

and specific, and the acquirer will be made aware of how to recognise and realise the legitimate text” (1996:60). In performance models the educator has a directive, possibly even instructional, role in the transmission process (Bernstein, 1996).

Bernstein (1996, 2000) further distinguishes between different modes of performance depending on the knowledge-base; singulars (disciplinary knowledge), regions (professional knowledge) and generic (a lower level of vocational knowledge). The generic mode refers to a competency-based education model; as Bernstein argues that it is “produced by a functional analysis of what is taken to be the underlying features necessary to the performance of skill, task, practices or even area of work. These underlying features are termed competences” (2000:53).

For Bernstein a competence pedagogic outcome, based on an invisible or implicit pedagogy, is characterised by weaker classification and framing. Competence models stress that which is internal to the acquirer and assume that learning takes place through the realisation or actualisation of competences that the learner is thought to possess already (Bernstein, 1996). In competence models educational goals are ‘hidden’ from the acquirer (or are not explicated) and evaluation criteria are generally implicit. The teacher’s role is seen to involve the management and facilitation of the classroom process as opposed to direct instruction (Bernstein, 1996; Rose, 1999). Clearly, the competence model is tied up in the language of progressivism (Muller, 2002).

2.3.2 Craft as a means to explore the pedagogic practice suitable to ‘work of risk’: a presentation of Gamble’s empirical model

The clearest empirical evidence of a ‘risk’ pedagogy, that is analysed according to Bernstein’s framework, is Gamble’s (2004) study of the craft of cabinet-making. In her Doctoral thesis Gamble explores “the relationship between tacit craft knowledge and its transmission practices” in a cabinet-making apprenticeship⁶ as work of risk (2004:182). Gamble first uses Bernstein’s concepts of classification and framing to unpack the pedagogic outcome of the craft curriculum. Thereafter she builds upon her formulation of this outcome to develop a complex theoretical understanding of the tacit dimensions of craft knowledge. This foregrounds the development of a capacity to grasp the relation between parts and whole through visualisation⁷.

⁶ The cabinet-making apprenticeship, investigated by Gamble, was delivered at the Furniture Industry Training Board training centre (referred to as the ‘trade school’ by apprentices).

⁷ In addition, Gamble analyses the structure of craft knowledge according to Bernstein’s concepts of vertical and horizontal knowledge. This analysis, while interesting, falls beyond the scope of my study.

Gamble's formulation of the pedagogic outcome of craft, examined below, serves as a central conceptual tool in my examination of the type of curriculum that is most suitable for high risk work such as train driving.

Gamble's analysis of the craft curriculum finds a mixed pedagogy or mixed pedagogic outcomes, depicted as follows:

Externally visible performance

Internally held competence

(Gamble, 2004:134-135)

The outcome of the pedagogy (that centres round a master-apprentice relationship) is found to be an external performance that is grounded or embedded in an internally held competence. Key to understanding this formulation is the unique manner in which the notion of competence is theorised. Gamble does not use the term competence in the procedural, CBMT, sense or in the progressivist sense in which Bernstein uses the concept (Bernstein 1996, 2000). She argues, instead, that internalised competence is characterised by a background of tacit knowledge, held in the body, which gives rise to the skilled performance. This internalised competence concerns "a capacity for visualisation", which is the purpose and outcome of the tacit pedagogic transmission in craft (Gamble, 2004:iii). Visualisation involves seeing a relationship between parts and whole, allowing the craftsman to visualise the ideal finished piece of furniture (Gamble, 2004). Gamble argues that "each craft or trade has its own version of an embodied principle of arrangement, which precludes predetermination of end-result and requires an act of interpretation or visualisation" (2004:180). Any form of craft is thus established as 'work of risk' in that the end-result is not predetermined and thus cannot be achieved only through workmanship of certainty.

Drawing on the work of Polanyi, Gamble argues that the development of this competence occurs within the context of the modelling relationship with the master; a process that is described by both master-trainer and apprentices in Gamble's study as "stealing with the eyes" (2004:152). What is conveyed in the modelling relationship is not procedural knowledge, but a time-space principle that allows acts of integration. This principle is conveyed through apprentices always working on a complete piece of furniture in the presence of the master as well as through the master demonstrating by way of drawings rather than words. Gamble argues that drawings are "the formal curriculum space in which interpretation of ordered relationships is acquired" (2004:147). In sum, then, visualisation is accomplished only when the apprentice has had sight of the whole production process;

which is acquired through the working on the set piece and gaining sight of both what is visible and invisible to the eye through technical drawings.

An important finding of Gamble's study is that a CBMT curriculum model is unable to take account of the capacity for integration that is acquired in this way. Gamble notes that while the cabinet-making apprenticeship was 'billed' as a CBMT curriculum, the pedagogic mode takes the form of a traditional cabinet-making trade apprenticeship where the hierarchical modelling relationship between master and apprentice is still in evidence and CBMT modules, while distributed, are ignored. Gamble argues that the procedural basis of the CBMT curriculum renders it incapable of transmitting tacit knowledge.

It stands to reason that a relation between part and whole can only be transmitted if both part and whole is present ... The logic of programme design that divides the curriculum into discrete tasks and elements of tasks following a sequential order is antithetical to the logic of an internally held coherence of which the order of relation is unspecifiable. The master-trainer's modelling of this logic is no longer possible under the pedagogic conditions created by competency-based modular training. (2004:155).

What is clear from Gamble's study is that, on its own, CBMT cannot transmit the kind of expertise which precludes the predetermination of end result. It cannot transmit 'work of risk'. My study will investigate whether this is the case in other skilled work, for example train driving.

2.3.3 'Work of risk' entails both routinisation and discretionary judgement

A synthesis of the work of Gamble, Pye and Polanyi makes it evident that the pedagogic outcome of 'work of risk' concerns the ability to grasp the relationship between parts and whole, and act on this understanding. It is only when the significance of the whole is understood that the person is able to perform both the routine or habitual aspects of the work (aspects that can be controlled through certainty in the form of tools and techniques) as well as the complex, unpredictable aspects of the work.

The visible skilled performance of 'work of risk' can now be described as involving both routinisation and discretionary judgement. Routinised action is always found in skilled occupations; even high risk professionals, such as airline pilots or surgeons, perform routine tasks as part of their functioning. Routinisation introduces certainty into 'work of risk'.

The skilled performance, however, entails a great deal more than routinisation as the nature of 'work of risk' means that there is always unpredictability. In other words, routinised action is punctuated by moments of complexity and change which require explicit attention and action. This relates to what Pye refers to as the 'judgement and care' required in 'work of risk'. When confronted with change, the person cannot merely fall back on routinised habits but is required to make a complex, frequently instantaneous, decision. Rapid decision-making is understood as the ability to use *discretionary judgement* – discretionary emphasising the unpredictable nature of the work. However, if asked, an individual may not be able to describe all of the factors that went into making the discretionary judgement as, following Gamble and Polanyi, much of this is internally held.

2.4 The research hypothesis

The conceptual chapter has made three broad moves. It has examined the inherently unpredictable nature of 'work of risk'; it has presented Bernstein's conceptual understanding of pedagogic models, and has investigated the mixed pedagogic outcome of craft. The following hypothesis can thus be formulated:

- A curriculum and pedagogy that successfully transmits a capacity to handle risk must transmit a combination of the ability to make discretionary judgements as well as the ability to perform routinised action (or the ability for routinised rule following).
- Routinised rule-following per se does not necessarily lead to the exercise of discretionary judgement in unpredictable risk situations.

In my study I shall investigate how the risk-certainty tension is transmitted to trainee-train drivers and what curriculum components are required to do so.

The next chapter turns to a discussion of research methodology before the empirical case is presented in chapters 4 and 5.

Chapter 3: Research Methodology

3.1 Overview

This research study is rooted in a social realist approach to education and makes use of a qualitative research design strategy to investigate the curriculum and pedagogy that leads to the transmission and acquisition the capacity for risk work.

The social realist approach employed is informed by Bernstein's conceptual theory of knowledge structure (Wheelahan, 2010; Allais, 2010, Young and Muller, 2010). Bernstein's central claim was that everyday or "horizontal discourse", and disciplinary-based or "vertical discourse"; display fundamentally different internal structures with a strong boundary between the two forms of knowledge structure (2000:156). Continuing in the tradition of Bernstein, social realists have taken the differentiation of knowledge as a central tenet as "knowledge areas differ in their internal coherence, their principles of cohesion, and their procedures for producing new knowledge" (Allais, 2010:14).

It follows that knowledge lies at the heart of educational activity - the purpose of education is the transmission and acquisition of knowledge (Young, 2010; Wheelahan, 2010). In particular the need for disciplinary-based knowledge in any educational programme, whether general or vocational (Wheelahan, 2007, 2010; Young, 2010; Gamble, 2006) is stressed. The lack of attention to knowledge in the global⁸ adoption of national qualifications frameworks, and outcomes- or competency-based curriculum modes associated with national qualifications frameworks, is vehemently opposed by social realist thinkers (Wheelahan, 2007, 2010; Young and Muller, 2010; Allais, 2010; Gamble, 2004).

In relation to the VET curriculum, it is argued that the absence of disciplinary-based knowledge in the curriculum denies vocational students access to 'powerful' knowledge so that students leave a programme with no more knowledge and no greater employment opportunities than when they started (Wheelahan, 2007, 2010; Young, 2010). In pedagogic terms their exclusion from powerful knowledge means that students are not able to move above occupational tasks; it means that students are not able to progress in the occupation itself or contribute to the discipline in which the occupation is located (Wheelahan, 2007, 2010).

⁸ The NQFs started in Anglophone countries such as the UK, New Zealand Australia and South Africa but have now been implemented in more than 70 countries (Young, 2010).

A social realist methodology has been visible most predominantly in the school sector. Bernstein's work has been used in numerous empirical studies relating to schooling and higher education. In the area of schooling, studies have explored discipline specific issues such as the relation between social background and achievement in maths and science (Lubienski, 2004; Morais, Neves, Pires, 2004); the relationship between learning and knowledge acquisition and social class (Pedro, 1981; Morais, Neves, Fontinhas, 1999; Arnot and Reay, 2004), literacy and language in indigenous cultures (Rose, 1999; Rose, 2004); gender issues and gender identity (Daniels and Creese, 2004). Bernstein's theories have also been applied to teacher education (Ensor, 2004); and higher education – the recruitment and recognition of prior informal experience in university labour law courses (Breier, 2004) and the recruitment of experience in an adult education diploma (Haupt, 2005).

The use of the social realist approach is, however, expanding to the VET field. Social realist thinkers, Young (2006, 2010), Wheelahan (2007, 2010) and Gamble (2006) in particular, have focused on the improvement of VET through foregrounding the knowledge requirements of the curriculum. These debates have primarily taken place at the definitional or theoretical level, although certain empirical studies have focussed specifically on the vocational field. Hewson (2010) studied the selection and organisation of knowledge within a degree qualification in the hospitality industry. In her PhD, Wheelahan (2007) analysed two sets of case studies. The first set analysed access to disciplinary knowledge in nursing and hospitality (a higher education and vocational programme), while the second critiqued CBMT through comparing a community development course of the 'past' with a competency-based community development course. Gamble (2004) used Bernstein to code the tacit knowledge of a craft-based curriculum. As presented in the conceptual framework Gamble's empirical work is central to this dissertation, which focuses on the particular case of train driving as an instantiation of an occupationally-orientated curriculum.

3.2 Research strategy

This research adopts a qualitative research strategy informed by the conceptual framework and hypothesis developed in chapter 2. To restate; it is hypothesised that a curriculum and pedagogy that successfully transmits a capacity to handle risk must transmit a combination of the ability to make discretionary judgements as well as the ability to perform routinised action (or the ability for routinised rule following). The two central research concepts evident in the hypothesis are that **routinisation** and **discretionary judgement** are required in risk work and should thus be transmitted through the curriculum and pedagogy.

The decisions that informed the data gathering, data analysis and final conclusions of the study are embedded in these two concepts. Yin describes the move from a study's questions, to data collection and analysis, to conclusions as the "chain of evidence" of the study; highlighting the need to account for the methodological decisions that we make in order to ensure the validity of the study (1994:98). The methodological process described in this chapter provides an account of how I moved from Gamble's formulation of the outcome of craft (based on Bernstein's notions of performance and competence pedagogic models), as well as Pye and Polanyi's work in relation to skilled work, to the ultimate postulation that both routinisation and discretionary judgement are necessary to the risk curriculum.

3.2.1 A case study approach

This study uses a single qualitative case study approach to conduct an in-depth analysis of a CBMT vocational curriculum – a national diploma in train driving. The case study approach provides an opportunity for nuance and depth of analysis (Yin, 1994; Cohen, Manion and Morrison, 2007). The approach is appropriate to the present study as the aim is to conduct a detailed investigation into the 'inner workings' of the curriculum and pedagogy that leads to risk; and to explore the very complex nature of risk work itself.

The unit of analysis in this case study is the National Diploma: Train Driving (Mainline Operations), set at level 5 on the South African National Qualifications Framework. The diploma is delivered by the largest transport organisation in South Africa. The freight rail⁹ division of the organisation employs approximately 25000 staff nation wide. Due to the specialised nature of operations the rail organisation offers most of the training itself, through a network of regional training centres. A central training area is train personnel development (TPD) - the training of train drivers and train assistants. The national diploma in train driving is offered as part of TPD training. The diploma has two parts - an instructional component and an on-the-job training (OJT)¹⁰ component. Instructional training is delivered in a competency-based modular training format (CBMT) at the regional training centres, while OJT takes place at the train depot. Chapter 4 presents a detailed description of the structure of the diploma.

The case is purposively selected as the training of train drivers clearly involves a pedagogy that concerns risk or skilled work; which is the focus of this study. In addition, the adoption of

⁹ The rail division hauls mining freight (such as coal and iron ore), heavy and light manufacturing freight, various chemicals, automotives, containers, etc. The division also includes mainline (long distance) passenger services but not metropolitan passenger services, unless under agreement with local commuter service providers.

¹⁰ Hereafter on-the-job training will be referred to as OJT.

the CBMT system in the delivery of the national diploma in the last decade fits with the purpose of this research to examine whether CBMT is appropriate to vocational risk work. The case is also selected for pragmatic reasons - the research site is geographically accessible and the researcher has a prior relationship with the organisation. This allowed for the negotiation of access to entering the locomotives of trains; which is usually prohibited to 'members of the public'.

The remainder of this chapter describes the data collection strategy and the data analysis process that was followed in this study.

3.3 Data collection

3.3.1 *The data gathering strategy*

The data gathering strategy was developed to encompass training that take places at both the training centre and the workplace (the depot). It is well known that the inclusion of multiple sources of data, in a manner that considers possibilities for triangulation, enhances the internal validity of qualitative case studies (Yin, 1994; Mathison, 1988). The following issues were considered when selecting data sources in this study;

- Data sources needed to allow for a systematic comparison between the two distinct sites of practice. The same lines of enquiry needed to be probed in each site and this meant that the same data sources needed to be selected in each; for example the same type of documents would need to be reviewed in each.
- In order to facilitate the 'chain of evidence' the concepts of routinisation and discretionary judgement needed to be carefully considered in choosing data sources. For example, it was clear early in the research that routinised rule following would in all likelihood be evident in a review of training and assessment manuals; but gaining sight of discretionary judgement, which is difficult to account for in words, would require repeated observations in both sites of the diploma.
- The data collection strategy needed to allow for the collection of in-depth data that would not close down possibilities for exploring the two central concepts. This meant that identification of data sources was a flexible process that evolved as the researcher became acquainted with the case.

There were three broad data collection methods – a review of documents, interviews and direct observations. Data was collected from February 2007 to December 2008.

Document review

A number of policy and training related documents from both sites were collected and reviewed (detailed in appendix 4). Key CBMT-related documents included; the course schedule, the manuals for each module and the assessment scripts. Important OJT documents included practical training activity lists, the assessment outcomes and the criterion-referenced assessment checklist. Documentation was a rich source of data in the analysis of the curriculum; particularly of the CBMT component where the educators and assessors adhere closely to the course modules and multiple choice assessment scripts. Practical training documents provided an overview of assessment practices but needed to be examined alongside the observations of practical assessments; in order to provide an accurate picture of the OJT assessment.

Interviews

A total of ten interviews were conducted. A list of interview data sources is attached as appendix 5. Purposive sampling¹¹ was used to select research participants. Preference was given to key informants who, due to their position or experience, had valuable and relevant information to contribute (Huysamen, 2001). Interviewees from both sites included managers, trainers, assessors and trainees.

Interviews were conducted as follows:

- Two preliminary interviews were conducted with the training centre manager and educator 1 (who delivered the majority of the CBMT modules) in February 2007.
- The remainder of the interviews were conducted between September 2007 and December 2008; using semi-structured interview schedules (see Appendices 7, 9, 10 for interview schedules).
- Two semi-structured group interviews were conducted with trainees (see appendix 8).

In addition, all informal communication (for example a chat with the educator at the end of a class or with the assessor while waiting for a train) was noted. All interviews were recorded and transcribed, with the permission of participants.

Observations

Four observations were undertaken.

- The delivery of two randomly selected modules in the Bellville training centre was observed, over two full days, during October 2007.

¹¹ The exception is the two group interviews where trainees were randomly selected.

- Two practical assessments (which involved observing the assessor and trainee/driver on-board trains) were observed in November and December 2008¹². The assessments were selected according to the availability of the assessor. The first observation took place at the Worcester depot and the second at the Bellville¹³ depot.

Unstructured observations were conducted in all four observations. Unstructured observations, rather than structured observations with predetermined observation categories (Cohen et al, 2007), were conducted in order to gain an in-depth understanding of learning processes as well as tacit practices that could not be elicited in interviews. Detailed observation notes were taken to avoid drawing conclusions prior to comparing observations with data from other sources. Categories or themes were developed inductively (Cohen et al, 2007).

3.4 Analysis and presentation of findings

Yin argues that “the analysis of case study evidence is one of the least developed and most difficult aspects of doing case studies” (1994:102) and suggests that one solution is to rely on the theoretical propositions set up at the start of the study. In analysing the findings in this study I returned to the conceptual framework and the claim that both routinisation and discretionary judgement are required in work of risk. In particular I returned to Gamble’s formulation of the pedagogic outcome of craft.

In her analysis of the cabinet-making curriculum Gamble employed Bernstein’s analytical concepts of classification and framing (Bernstein, 2000) to develop a set of classification indicators and framing types (evaluation criteria) as a coding device¹⁴. Such coding devices are, in Bernstein’s terms, a language of description, which he describes as a “translation device whereby one language is transformed into another” (2000:132). Bernstein distinguishes between an internal language of description, which refers to the theoretical framework; and an external language, which refers to an analytical framework that operationalises the theoretical concepts employed (Moore and Muller, 2002). In this study the conceptual framework developed in chapter 2 is the internal language and Gamble’s coding device (adapted to this study) is the external language of description.

¹² The gap between observations in the training centre and the depot was due to the researcher being pregnant and not being allowed on trains or in the yard (the train operating) area.

¹³ The research site was located in Bellville (a suburb of Cape Town). Worcester is a large farming town about 180kms outside of Cape Town. Trainees from the Worcester depot receive training at the Bellville training centre.

¹⁴ Gamble identified both external and internal classification and framing codes. The scope of this dissertation limits analysis to internal classification and framing only.

I need to stress that although Gamble's coding device is a crucial tool in the analysis of my data it is not blindly accepted. As researcher I am aware that a device "is not meant ... to be a straightjacket into which the data is stuffed and bound" (Bettis and Mills, 2006:68). There were thus two analytical phases. The first phase involved engaging with Gamble's coding device and my initial data in order to come up with a set of adapted classification and framing indicators for my study. In addition to Gamble's device, knowledge types were categorised using Bloom's revised taxonomy, as described below.

The subsequent phase involved the scrutiny of data in terms of these indicators and criteria. The phases were not distinct. Indicators and criteria were refined as the analysis unfolded.

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3.4.1 Phase 1: the adaptation of Gamble's classification indicators and framing types

This section presents Gamble's coding device in two parts. For each category of classification indicators (table 1) or evaluation criteria (table 3) Gamble developed a set of classification or framing modalities using Bernstein's classification and framing notation system¹⁵.

Classification

Gamble delineates two broad categories of internal classification, as illustrated in the following table.

Table 1: Internal classification of boundaries between spaces and between discourses (Gamble 2004:80, 83, 89)

Category	Indicator	Classification modalities			
		C++	C+	C-	C--
Space	Inside and outside the workshop	High degree of specialisation. Strong boundaries between physical spaces, which are never transgressed.	Although there is high degree of specialisation of physical spaces, the boundaries between spaces are occasionally transgressed.	Significant degree of overlap or intersection, although specialised physical spaces are still clearly identifiable.	Minimal differentiation and little means of distinction between physical spaces.
	Trade workshops				
	Between different sections of the trade school				
	Between apprentices				
	Between master-trainer and apprentices in the workshop				
	Between master-trainer and apprentices outside the workshop				
Curriculum boundaries	Between the curriculum for each trade	High degree of specialisation. Strong internal curriculum boundaries, which are never transgressed.	Although there is a high degree of specialisation, internal curriculum boundaries are occasionally transgressed.	Significant degree of overlap or intersection of internal curriculum boundaries within a system of formally separate curriculum spaces.	Minimal differentiation and little means of distinction between internal curriculum boundaries.
	Between school woodwork and cabinet making				
	Between 'theory' and practice				
	Relation between modules				
	The distribution of tasks and activities				

¹⁵ Notation for classification: C++, very strong classification; C+, strong classification; C-, weak classification; C--, very weak classification. Notation for framing: F++, very strong framing; F+, strong framing; F-, weak framing; F --, very weak framing.

In the initial comparative analysis between my data and Gamble's device all her classification indicators were used, with additional indicators added. However, as data collection and analysis continued the set of classification indicators was refined. Gamble's six spatial boundary indicators were adapted to four indicators in the present study; the adaption of indicators is detailed in appendix 6(A). Her five curriculum boundary indicators were adapted to three indicators; depicted in appendix 6(B). Table 2, below, summarises the indicators used in this study. Gamble's operational definitions of the classification modalities were used unaltered.

Table 2: Indicators used in the analysis of classification in the train driving national diploma

Classification indicators
Indicator 1: Between site of curriculum and site of work
Indicator 2: Sites of learning for different rail functioning areas
Indicator 3: Between trainee train drivers
Indicator 4: Between educator and trainee train drivers
Indicator 5: Between the curriculum of different rail functioning areas
Indicator 6: Between 'theory' and practice
Indicator 7: Between modules

Framing

In the study of the craft curriculum, Gamble investigated framing in relation to selection, sequencing, pacing and evaluative criteria. This study focuses on evaluative criteria only for the following reasons:

- Evaluation involves examining the performance of the trainee train driver. It follows that confirmatory or contrary evidence of the visible skilled performance (as routinisation plus discretionary judgement) is likely to be found in the evaluation practices of the course.
- CBMT is assessment-led and so evaluation should be foregrounded in any analysis of competency-based programmes.
- In the OJT component the final practical evaluation (akin to the trade test in the case of an apprenticeship) is the ultimate determinant of readiness as a train driver.
- Regular evaluation (or re-licensing) is a key safety requirement in train driving.

Gamble's coding device for framing over control of evaluation criteria is illustrated in the following table.

Table 3: Framing (internal) of control over evaluation criteria (Gamble, 2004:113, 118-119)

Category	Type		Framing modalities			
			F++	F+	F-	F--
Criterion rules (evaluation criteria)	Explicit criteria	<ul style="list-style-type: none"> Control over criteria of accuracy and precision Control over criteria of tool usage and materials 	Explicit and specific criteria are transmitted in oral, written or visual form	Although criteria are transmitted mainly through modelling their presence is clearly signalled	Criteria are implicit or diffuse and acquirers are not always made aware that they are being evaluated	Criteria are implicit and diffuse and acquirers are not made aware that they are being evaluated
	Implicit criteria	<ul style="list-style-type: none"> Control over criteria of readiness 				

Gamble observes two levels of evaluation criteria in the cabinet-making curriculum; the first set of criteria operate at the explicit level and the second set at the implicit level.

In my study Gamble's two explicit framing criteria over evaluation guided the development of the evaluation criteria that constitute the specialised pedagogic context of train driving - the demonstrable skills which enhance safe train operations. Identifying the implicit criterial rules of train driving involved an examination of the assessment practices of the train driving diploma and, while the implicit criterion of readiness found in the cabinet-making curriculum was a useful guide, it was necessary to scrutinise my own data closely in order to 'name' the implicit criteria in this study. Table 4 depicts the evaluation indicators used in this study. As with classification, Gamble's operational definitions of the framing modalities were not adapted.

Table 4: Evaluation criteria used in the analysis of framing in the train driving national diploma

Explicit criteria	Implicit criteria
Criterion 1 – adherence to train working rules	Criterion 5 – confidence in train handling
Criterion 2 – knowing the locomotive	Criterion 6 – concentration in train handling
Criterion 3 – safe operation of brake systems	Criterion 7 – use of discretionary judgement in train handling
Criterion 4 – safe train handling	

3.4.2 Phase 2: data analysis in terms of the adapted classification indicators and framing types

Phase 2 involved two levels of analysis. The first level dealt directly with the train driving diploma data and established the strength of classification and framing in the CBMT and OJT components of the diploma. The second level of analysis involved comparing the findings of the present study with Gamble's findings of the cabinet-making curriculum.

In the first level of analysis, the classification relations of each of the components of the diploma were examined. All sources of data (as detailed in appendices 4 and 5) were analysed and triangulated according to the adapted classification indicators. The analysis focused on how each of the components fitted within either a competence or performance pedagogic model in order to establish whether the competence-performance relationship found in the pedagogic outcome of craft, as presented in the conceptual chapter of this study, could be found empirically. The classification findings are presented in chapter 4.

Thereafter, the evaluation practices of both components of the diploma were analysed and the evaluation criteria were refined and framing modalities were assigned. Central to the analysis was the focus on the kind of knowledge required (produced) by the criteria as well as the priority afforded the knowledge type in the delivery of the diploma. Knowledge was categorised as *procedural*, *factual*, or *conceptual*, using Bloom's Revised Taxonomy of educational objectives (Anderson and Krathwohl, 2001, in Gamble, 2009), as summarised in table 5 below. Tacit knowledge was analysed based on the work of Polanyi and Gamble, as detailed in the conceptual framework (see 2.2.2 and 2.3.2).

Table 5: Revised taxonomy of educational objectives (derived from Bloom's taxonomy)

Factual knowledge refers to "the basic elements that students must know to be acquainted with a discipline to solve its problems". It is knowledge of specific terminology and elements in the subject area.
Procedural knowledge refers to "how to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods"
Conceptual knowledge refers to "the interrelationships among the basic elements within a larger structure that enable them to function together". This is the knowledge of classifications, principles and generalizations as well as models and theories.

(Adapted from Anderson and Krathwohl (Eds), 2001, as cited in Gamble, 2009).

The second level of analysis involved a comparative analysis of the classification and framing relations found in the train driving diploma with those found in Gamble's study of the cabinet-making apprenticeship. The analysis is presented in chapter 6.

3.4.3 Presentation of findings and analysis

Findings are presented, over two chapters. Where direct quotes, from interviews or observations, are offered as empirical evidence the transcript or field note code is provided (as detailed in appendix 5). The analysis of findings is presented as the final chapter.

3.5 Validity

Validity can be understood as “the trustworthiness of inferences drawn from data” (Eisenhart and Howe, 1992:644 in Freeman, de Marrais, Preissle, Roulston and St. Pierre, 2007). Case study methods are often critiqued for various perceived methodological flaws, such as running the risk of selectively attending to data (Flyvbjerg, 2004). In addition, it is sometimes argued that qualitative case studies are empirically ungeneralisable and therefore of limited research value (Yin, 1994). However, rigorous engagement with a study’s theoretical framework, as well as strategies like triangulation, can increase the trustworthiness of data and conclusions and allow for analytical generalisation (Yin, 1994; Mathison, 1988; Flyvbjerg, 2004; Gamble, 2004; Anfara and Mertz, 2006).

In this study triangulation of multiple data sources and a number of different data collection techniques aimed to achieve internal validity.

While a single case study does not necessarily provide a basis for generalisability or external validity, this study consciously engaged with a prior theorisation of a form of vocational curriculum and pedagogy (Gamble 2004), with the intention of testing whether the findings could be correlated by another study in an unrelated occupationally-orientated field. Should this prove to be the case then the findings of the present study would have wider theoretical generalisability. In other words, the findings of this study, as presented in the next two chapters sustains this claim and it can thus be postulated that the conceptual model of the transmission of ‘risk work’, as developed in this study, may be relevant to a wider range of vocational curricula (Cohen, et al 2007).

3.6 Ethical Issues

Written permission for the research to be conducted in the rail organisation was received from the human capital (human resources) general manager. In addition, the head of the school of rail and the training centre manager agreed to the research. The rail organisation is the only one of its kind in South Africa and while not named the anonymity of the organisation cannot be guaranteed. However; the managers consulted in the process of negotiating access were aware of this and supported the research. All researcher participants agreed to participate with full knowledge of this constraint. The confidentiality of research participants was ensured.

The two chapters that follow present the findings of the study.

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Chapter 4: The Structure of the Curriculum

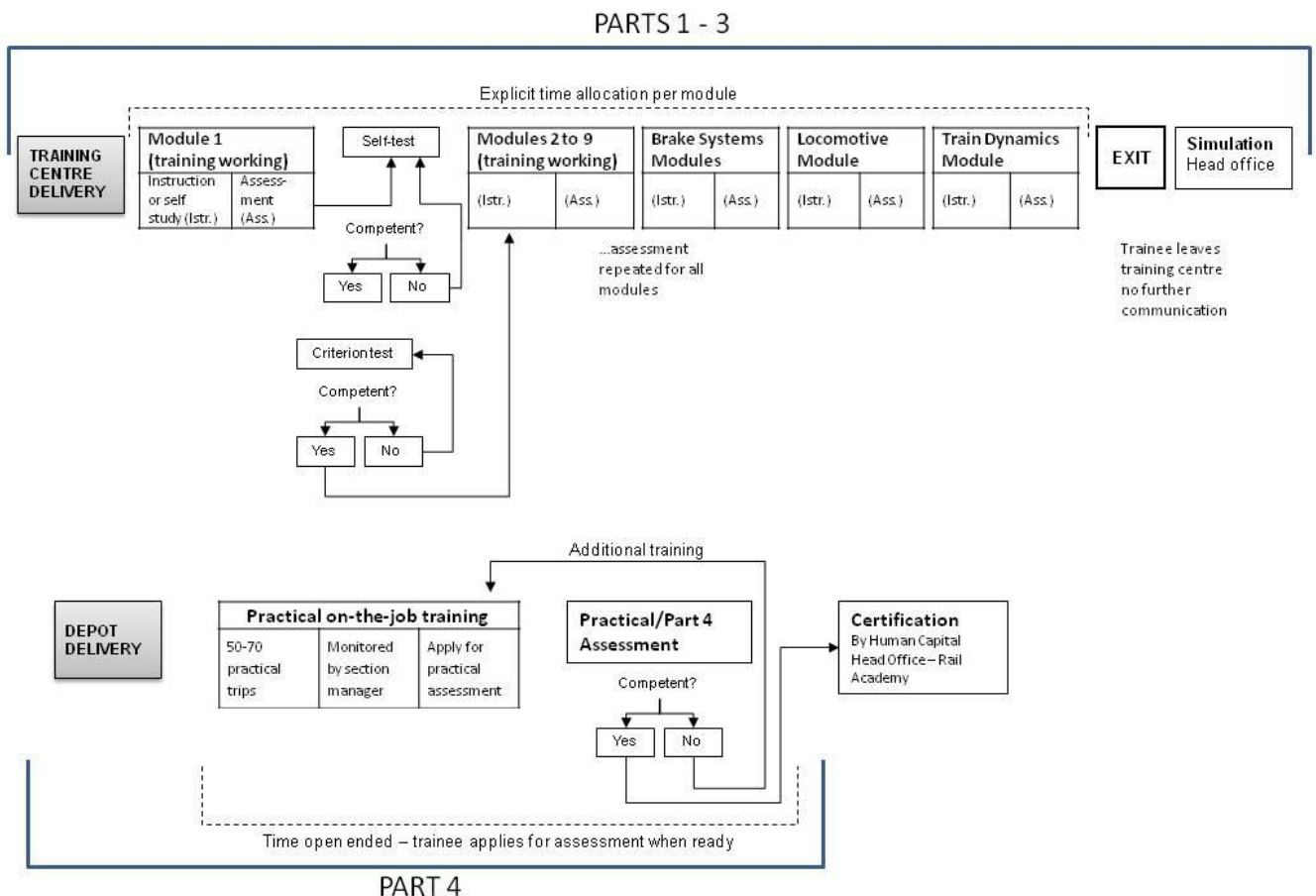
4.1 Overview

This chapter explores the structure and pedagogy of the diploma curriculum. In this study what are essentially two pedagogic sites are examined - the training centre or instructional site (the CBMT component) and the workplace learning site (the OJT component). This chapter first outlines the structure and assessment process of the diploma. Thereafter, the chapter analyses the classification of each component using Gamble’s (2004) coding device (table 1, chapter 3 refers).

4.2 The structure of the national train driving diploma

The national diploma consists of parts 1 to 4 but in effect there are only two parts. Parts 1-to-3 refer to the modular or instructional component (referred to by the majority of research participants as the ‘theory’ of the programme) and part-4 refers to on-the-job training (OJT). The following figure provides an overview of the national diploma.

Figure 1: Diagrammatic overview of the National Diploma: Train Driving (Mainline Operations)



* Note a larger version of this diagram is reproduced as appendix 3.

Trainees completing the diploma are already employed at the organisation and are required to have been employed as train assistants¹⁶ for at least two years prior to being allowed on the diploma. Grade 12 maths and science are entry requirements¹⁷.

4.2.1 The CBMT instructional component (parts 1-3)

'Theoretical' training is offered in the regional training centres physical and administratively removed from the site of work and is delivered according to the competency-based modular training system (CBMT). The centre forming part of this case study is based in Bellville, Cape Town, and provides yards¹⁸ and TPD training to all train depots in the Western Cape. The centre provides re-licensing training for experienced drivers (a national safety regulation implemented every two years) as well as initial training for train assistants and train drivers (the diploma being studied).

A course map (appendix 2) for the instructional component details all modules as well as a time stipulation for each module. The duration of the instructional component is approximately four months. Modules cover four areas – train working rules, brake systems, locomotive type as well as train dynamics/handling. The modules are designed as self-study modules - the premise is that trainees proceed on their own according to their own ability. In the CBMT system trainers should only be facilitators; answering questions and conducting assessment. However, this seems to only be the case in large training centres, with over 600 trainees. The Bellville training centre offers the programme through instruction, what the educators refer to as "talk-and-chalk"¹⁹.

Three educators at the Bellville training centre are responsible for delivering both initial and re-licensing training. Educators come from a depot environment and drive trains regularly in order to remain licensed as TPD trainers. Two trainers were involved in delivering the diploma, referred to in this study as educator 1 and educator 2. Educator 1 taught the bulk of the modules – nine train working rules modules, as well as the brake and locomotive modules; educator 2 taught the train dynamics module.

¹⁶ A train assistant works with the driver in the locomotive cab and assists the driver to check signals; change points and to get off the train if needs be (such as if the train is stuck and warnings need to be placed behind the train).

¹⁷ A few research participants reported that this requirement is unevenly applied.

¹⁸ Yards staff marshal trains in and out of the yard, for example they will couple wagons or coaches to the locomotive.

¹⁹ A second language phrase for 'board-and-chalk'.

Assessment in Parts-1-3

Assessment processes, and related criterial rules, are discussed in detail in chapter 5; here it is sufficient to note that the trainee needs to successfully complete a criterion test for each module before proceeding to the next.

Trainees return to the depot on completion of their last module. Trainees should attend simulation training before commencing part-4, on-the-job training (OJT). Simulation takes place at national level; where trainees are placed in a train simulator to learn how to handle a train. In reality the demand on the simulator is great and trainees frequently commence OJT without having completed simulation. They are, however, required to complete simulation in order to be awarded the diploma. The training centre is not involved in organising simulator training and in effect trainees exit the training centre system once the modular training is complete.

4.2.2 The on-the-job-training component (part-4)

Trainees commence OJT on return to the depot, whether or not they have completed the simulation training. There is no communication between the depot or training centre on administrative or training related matters. The OJT training takes place at local depots where trainees are employed. The OJT assessment practices at the Bellville and Worcester depots are examined in this study.

Trainees are placed with experienced train drivers who fulfil the role of driver tutors²⁰. Trainees are required to complete 50 to 70 practical trips (depending on the brake system in use at the depot) which are recorded on activity sheets. Section managers²¹ monitor training by accompanying driver-tutors and trainees on trips from time-to-time. However, immense workloads at large depots, such as Bellville, result in managers not always being able to effectively fulfil their monitoring role and this allows tutors a fair degree of autonomy. The duration of part-4 is approximately three and a half months but time is fairly open-ended depending on trainees' progress as well as the availability of locomotives (in smaller depots trainees may need to wait longer for the opportunity to drive). When a driver-tutor and trainee feel the trainee is ready for the part-4 assessment this is communicated to the section

²⁰ The term driver-tutor is inconsistently used in the training environment but used in this research to distinguish driver-trainers from training-centre-educators. Contradictory reports were provided regarding whether trainees are assigned to one driver for the duration of the practical training. It is also reported that at times drivers provide part-4 training without having sufficient driving experience (in some cases under four years).

²¹ The Bellville depot has a number of section managers who work different shifts. Section managers are responsible for monitoring train drivers and assistants, which involves conducting task observations on already qualified drivers, monitoring the hours of drivers' shifts, other administrative tasks and monitoring part-4 training.

manager who conducts a pre-assessment. Pre-assessments can be repeated until such time as the section manager feels the trainee is ready. Thereafter the section manager submits an application to the human capital (human resources) head-office for the final part-4 assessment.

OJT assessment

Part-4 assessment involves an assessor practically assessing a trainee driving a train. Two attempts at the part-4 assessment are allowed. The practical assessment is discussed in chapter 5. Once the trainee has been found competent in the part-4 assessment application is made to head office for certification.

From this initial overview of the case it emerges that although there has been a national move to CBMT in the vocational arena in reality there may be sites of practice, such as the train driving diploma, where the shift has not been complete and in fact a hybrid pedagogic model (framed as CBMT but which borrows from other forms of training) is evident. In answering the question of the curriculum model suitable to risk work this dissertation will unpack the nature of such a hybrid and investigate the pedagogic implications of the hybrid.

4.3 Classification in the national diploma in train driving

The chapter now presents the analysis of classification in the diploma across the categories of space, agents and discourse to establish how each component of the diploma fits within a performance, competence or mixed pedagogic model.

Seven classification indicators are used in the analysis; depicted in table 2 of chapter 3. The analysis first examines the CBMT component in terms of all seven indicators and then runs the OJT component through the same set of indicators. Classification strengths for each indicator are assigned according to the modalities developed by Gamble (2004) and presented in chapter 3. These modality tables are repeated in the section that follows for the reader's convenience.

4.3.1 Classification of the CBMT instructional component

Boundaries between spaces

Spatial boundaries are analysed in relation to the following classification modalities:

Table 6: Classification modalities - spatial boundaries

C++	C+	C-	C--
High degree of specialisation. Strong boundaries between physical spaces, which are never transgressed.	Although there is high degree of specialisation of physical spaces, the boundaries between spaces are occasionally transgressed.	Significant degree of overlap or intersection, although specialised physical spaces are still clearly identifiable.	Minimal differentiation and little means of distinction between physical spaces.

(Gamble, 2004: 80).

Indicator 1: Between site of curriculum and site of work (C++)

There is a strong physical boundary between the training centre and the depot, which is a working rail yard. The training centre presents as a generic conference centre and the only indication to the contrary is decorative features, such as an old steam locomotive at the entrance to the building. Facilities at the centre do not in anyway match workplace facilities; for example there are no workshops or practical training facilities. Instructional educator 1 comments that there is a need for more rail specific facilities at the centre; "If I was in that position to ask them [management] for a coach, to actually provide a coach for us, to drive with the trains and give class on the train just for one day to show them – 'there is that now, can you see the aspect of that signal'." (transcript 3). In sum, the training centre is specialised in terms of educational or teaching requirements; the centre clearly presents as a school and not work. These very strong boundaries indicate a C++ modality as boundaries between the two sites (curriculum and work) are never transgressed.

Indicator 2: Sites of learning for different rail functioning areas (C++)

Two rail functioning areas are delivered within a single training centre - train personnel development (the training of train drivers) and yards training. Each functioning area is located in different parts of the training centre and taught entirely separately; for example of the nine classrooms in the training centre one or two are used in the delivery of the instructional component of the diploma (the train personnel development). There is a small communal canteen area, where all trainees are served lunch but usually as separate groups. The spatial boundaries between the different functioning areas are never transgressed. These boundaries keep train driving distinct as a specialised area; a C++ modality.

Boundaries between agents

The following table of classification modalities in relation to agents is replicated from Gamble's (2004) coding device:

Table 7: Classification modalities - boundaries between agents

C++	C+	C-	C--
High degree of specialisation. Strong boundaries between agents are never transgressed.	Although there is high degree of specialisation, boundaries between agents are occasionally transgressed.	Significant degree of overlap or intersection, between boundaries.	Minimal differentiation and little means of distinction between boundaries between agents.

Indicator 3: Between trainee train drivers (C+)

In the delivery of the train driver diploma desks are arranged in rows with four trainees sharing a desk. Trainees sit in the same position throughout the course and individually work through manuals. Trainees do occasionally communicate or share stationery. The separation into rows with an individual focus on the educator or manuals as opposed to sitting in more communal circular tables and engaging in group work indicates a distinction (C+)²² between agents. A C++ value is not assigned as there is occasional boundary crossing between agents with some sharing of desk space.

Indicator 4: Between educator and trainee train drivers (C+)

There is a clear demarcation between educator and trainees; the educator is in front of the class behind his own desk although he occasionally strolls the aisles. The staff room is 'off limits' to trainees. The demarcation between agents is occasionally transgressed as the educator has an open door policy, where trainees can walk into his office when he is present without obtaining permission (although the door is locked when he is not there as the self-tests are in his office). Despite this limited boundary crossing the teacher remains 'the expert' distinct from the trainee and a C+ modality is assigned.

²² As mentioned above the intention of the CBMT system is that trainees can work through the modules at their own pace and write tests when they are ready; a system that is individualised and keeps trainees separate in the learning process. Teaching the course, as is the case in Bellville, is not necessarily standard and the slightly weaker classification modality found here may not apply to all training centres offering the diploma.

Boundaries between discourses (curriculum)

Curriculum boundaries are analysed in relation to the following classification modalities:

Table 8: Classification modalities - curriculum boundaries

C++	C+	C-	C--
High degree of specialisation. Strong internal curriculum boundaries, which are never transgressed.	Although there is a high degree of specialisation, internal curriculum boundaries are occasionally transgressed.	Significant degree of overlap or intersection of internal curriculum boundaries within a system of formally separate curriculum spaces.	Minimal differentiation and little means of distinction between internal curriculum boundaries.

(Gamble, 2004: 83)

Indicator 5: Between the curriculum of different rail functioning areas (C++)

The train driving curriculum is specialised and distinct from other rail related training programmes, such as the training of rail artisans (maintenance) or yards staff. As illustration, the driving diploma makes no reference to the content of the yards course, despite drivers and yard staff at times working alongside each other in the depot. These distinct curriculum boundaries are supported by the structural arrangements of the organisation which keep areas of expertise apart, for example maintenance is a separate division within the 'mother' company.

There are, however, instances where the curriculum 'borrows' from other areas of expertise, such as electrical maintenance, but within clearly demarcated limits for specific purposes only. One such example is how to identify a fault with the locomotive, evident in the following extract from the 'electric locomotive series 6E' manual. The manual includes various faults that might be discovered by a train driver such as sparks on the pantographs (the apparatus which connects the locomotive to the overhead electricity cables).

How to identify sparking:

Excessive sparking is when you can hear the sparking in the cab and see the area around the train light up or even feel the unit jerk. When such sparking happens, the train must be stopped and inspection must be done to the wire and the pantograph.

What will you do then?

1. Stop the train!!!
2. Lower the pantographs on the train!
3. Report to CTC through the emergency number 1080!!!! And WAIT for the experts to be called out!!!

The phrase 'WAIT for the experts to be called out' is repeated at various points in the manual. The implication is clear – while the train driver needs to know how to identify the problem, it is not within his/her expertise to deal with the problem. Thus despite some content borrowing 'train driving' is a discrete subject area; there is a high degree of specialisation and very strong classification (C++) is found.

Indicator 6: Between 'theory' and practice (C+)

The instructional component of the train driving diploma is characterised by a marked distinction between theory and practice. There are two dimensions which serve to keep theory and practice apart. The manner in which theory is proceduralised and defined as 'that which can be written down', as well as the unresolved debate about whether the curriculum is over-inclusive or does not sufficiently cover the full range of expertise needed by a train driver.

In relation to the *first dimension* it is necessary to understand how theory is defined in the diploma. All research participants in this study view the CBMT modules as the 'theory' of the diploma. The modules are not theory in the sense of having a principle-based knowledge form; they are only considered 'theory' because they are *written down*. Much of the instructional component (particularly the train working rules modules) of the diploma is a form of *procedural knowledge*; primarily evidenced in the way that the modules operate like a policy and procedures manual as opposed to a learning text. Further empirical evidence concerning the procedural knowledge produced in the CBMT modules is presented in chapter 5.

The strong focus on that which is written down versus experience in practice points to well established boundaries between theory and practice. Educator 1, who facilitated the majority of the instructional component and all of the train working rules modules, confirms that the written modules are the theory of the course and there is a clear difference between learning something in theory and applying it in practice. The educator describes the difference; "Well if you look at theory you learn the stuff, you learn it. The practical is what you have learnt, you must apply what you have learnt in the theory. That is why I see the theory is in your course reader" (transcript 3). The educator argues that the written form of the curriculum is an important foundation, without which trainees would be lost.

Similarly, educator 2 speaks about having everything in writing, as opposed to relying on the experience of driving trains as was the case in the past when there was a stronger apprentice-like system. Educator 2 taught the train dynamics module, the module which refers to the scientific principles²³ of train driving, and recognises the importance of documenting the core principles of train driving:

²³ The science that is taught in this module is explored in further detail in the analysis of evaluation criteria in chapter 5.

Train dynamics, you see in the old days we have driven trains, you must do this and that, nothing in writing. Now we have everything in writing. How to maintain a constant speed, what does the word constant speed mean - that gives you an idea that all the powers, wind resistant from the front, pulling power, gradient forces everything must be in balance to maintain a constant speed. Now we have got it (transcript 6).

The emphasis on 'that which can be documented' does, however, present a challenge. Educator 1, while highlighting the need for theory, emphasises the need for practical exposure in the training centre component as well. He explains that it is difficult to get trainees to assimilate the numerous train working rules in a completely decontextualised manner;

If you look at the radio train orders on the branch lines there is a certain way of doing things we don't have equipment to listen to the TCO [train control officer] here from Malmesbury. You need to go on a locomotive and listen and see what they actually do Now you are trying to get them to imagine it; now it is very difficult; here is the stuff lets go through it ...Give us a day for practical, take the learners out, let them see if they can catch what is in the theory in the practical operation (transcript 3).

In addition, trainees describe finding it difficult to make sense of the 'theory' in isolation. In both trainee group interviews trainees requested more practicals in the training centre.

The second dimension that perpetuates the insulation between theory and practice is the unresolved debate about *what should be included in the 'theory'* of the curriculum. There are two poles in the debate; the one is that the theory should be kept to a minimum and the other is that the trainee needs a broader understanding and crucial aspects of train driving are being neglected within the curriculum.

The first position is held by educator 1 who calls for the compartmentalisation of knowledge. He proposes that a driver should only be taught content that is of immediate use to a driver's specific field; for example what a particular valve is called and not how it operates – technical knowledge which in his view falls within the knowledge domain of fitters or technicians. The opposing position, held by workplace practitioners and the training centre manager, is that the current curriculum is too narrow, is delimiting knowledge and is not assisting trainees to develop a concept of the big picture which aids in decision making; for example claiming that the curriculum should extend beyond merely naming parts or faults on a locomotive. This discussion is taken up in chapter 5.

Overall, very strong classification (C++) is found between 'theory', the modules, and workplace practice. The instructional component focuses on a compartmentalised or procedural knowledge form and is kept distinct from the practice that it is supposed to describe.

Indicator 7: Between modules (C+)

As described above the instructional component is made up of four sections - train working rules, brake systems, locomotive and train dynamics.

All modules are distinct from each other and this is cited by all research participants²⁴ as the greatest weakness of the CBMT model. Analysis of modules reveals a lack of integration across modules and no examples of cross-referencing. The task of integration is left entirely up to educators and trainees. Educators report referring back to completed modules although this was not seen in the two modules observed. The training centre manager argues that trainees are not able to integrate learning across modules. Commenting on the advantages of the CBMT model versus the previous training system the manager asserts;

I don't think there are any advantages really; maybe it is because I am from the old school ... what currently happens: your learner will go through module 5, single lines, and once he had done module 5 he actually leave[s] the curriculum material –some of them leave the material right in the college. Because as far as they are concerned 'I am done with that module, I don't want to deal with it anymore in my life'. Whereas in the past you know you had these 3 books, you need to take it with you in your satchel, and you never saw it as separate modules you saw it as this is what I need. Our facilitator calls it 'this is your bible and you will take it' (transcript 7).

A significant finding is the marked boundary between the brake systems, locomotive and train working rules modules (more procedurally orientated modules) and the train dynamics module. Train dynamics concerns the technical and scientific aspects of driving a train and has a fairly defined boundary from the procedural modules. This distinction is examined in the discussion of evaluation criteria in chapter 5.

Boundaries between modules (particularly between the procedural and technical modules) are never transgressed and modules are taught separately; a C++ modality is assigned.

In sum, all classification indicators are strong to very strongly classified in the instruction component of the diploma.

²⁴ Trainees did not comment on the structure of modules.

4.3.2 Classification of the OJT component

The OJT component of the diploma refers to the practical training that takes in the workplace. The tables of classification modalities above refer.

Boundaries between spaces

Indicator 1: Between site of curriculum and site of work (C- -)

In contrast to the training centre the practical training is basically indistinguishable from the facilities and arrangements of the depot; the spatial arrangements of the depot are highly specialised in terms of rail requirements. Training takes place while sitting in the locomotive cab²⁵ and driving the train. There is minimal differentiation between the location of training and the site of work; these permeable boundaries are indicative of a C- - classification strength.

Indicator 2: Sites of learning for different rail functioning areas (C+)

Sites of learning for different train operations or functions are separate. For example yards trainees and train driver trainees work in discrete environments (the yard versus the cab); this indicates distinct boundaries. However, trains operate out of the depot where all functions operate alongside each other (including locomotive maintenance) and this leads to a slight weakening or occasional transgression of boundaries; hence a C+ and not C++ modality is assigned.

Boundaries between agents

Indicator 3: Between trainee train drivers (C++)

Trainee train drivers work in isolation of each other for pragmatic reasons; only one person can drive a locomotive at a time and the space in the cab cannot accommodate more than the trainee, driver and train assistant. Also, there is no communal area where trainee drivers interact or receive training as a group. Train drivers and train assistants arrive at the depot, sign on duty and proceed directly to the locomotive they will drive for their shift without interacting with other staff for any extended period. The sharp spatial boundaries observed between individual trainee train drivers indicate very strong classification (C++).

²⁵ The locomotive cab is the space where the driver sits behind the train controls and operates the train; also referred to as the 'footplate'.

Indicator 4: Between educator and trainee train drivers (C-)

There is a fluid relationship between the educator and trainees. The driver tutor imparts his/her experience and knowledge of train driving while the trainee drives the train. The section manager in Bellville comments that the trainee comes from the training centre²⁶ and is quickly placed behind the controls and learning commences;

He will start as from the first day riding the train. His trainer will sit right behind him and he will lead him in the whole situation. At this stage release the brakes, open the throttle, if you go on a down gradient go into electric brakes or make a brake application or whatever the situation might be. You will lead him on how to use the controls in the right way on the locomotive (transcript 10).

Classification is weak as the cab is very much a shared space - trainee drivers and their tutors work together for long periods in the small locomotive cab. The practical assessor describes it as “your living environment for 12 hours sometimes even longer” (field note 3). There is a significant degree of intersection between boundaries, the trainee and tutor work in close proximity, but some differentiation is evident in the manner that the tutor initially gives instructions (when to release the brake and so on); a C- modality is allocated.

Boundaries between discourses

Indicator 5: Between the curriculum of different rail functioning areas (C+)

The demarcation between different rail functioning areas is slightly permeable in the workplace setting where the train driver needs to make rapid decisions based on a number of interrelated factors, which can include areas outside of the driver’s immediate ambit of expertise. For example, the practical assessor argues that in order for a driver to be able to effectively diagnose locomotive faults, and decide on corrective action, s/he needs an understanding of the technical operation of the locomotive; an area of ‘competency’ that strictly speaking (according to CBMT educator 1) falls within the domain of rail artisans. Hence in the actual practice of driving trains there is some degree of borrowing from other content areas, such as that of the technical trades, suggesting that boundaries are occasionally transgressed; a C+ modality.

Indicator 6: Between ‘theory’ and practice (C--)

Training in the work environment is not planned around the written curriculum (the modules). As outlined above the trainee needs to do either 50 or 70 practical trips before s/he can apply to be practically assessed. Each practical trip is recorded on an ‘activity sheet’ which stipulates the trainer’s and trainee’s particulars, the time on duty, the train number, the brake

²⁶The trainee by this stage should have gained some exposure on the simulator in Johannesburg, but this is not always the case as the simulator cannot keep up with demand.

system, the load of the train, the train route and a few lines for the “practical work performed by the trainer”. The form is an administrative document and not a curriculum document as there is no reference to specific content, outcomes or evaluation. The practical training depends on the experience that the driver tutor has accumulated in the field over a number of years and how this experience is imparted to the trainee is left up to the tutor’s discretion.

Overall OJT has a strong modelling on experience dimension and it is not possible to separate ‘theory’ from practice; modules are almost invisible in the OJT component. Yet this does not mean that ‘theory’ and content knowledge is not highly regarded by workplace practitioners; the assessor calls for in-depth, holistic knowledge (discussed in chapter 5). Also workplace practitioners are critical of the CBMT system as the trainees come to the depot and do not have basic knowledge; for example one section manager comments that “it is hair-raising” that trainees come from the training centre and do not know the meaning of warning boards.

In the OJT component of the diploma there is little means of distinction between ‘theory’ and practice boundaries. The practical work is the curriculum; a C -- modality is assigned.

Indicator 7: Between modules (C- -)

As indicated in the discussion of theory and practice above, modules are virtually invisible in the modelling system in the workplace. In fact, both section managers at the Bellville and Worcester depots, as well as the training centre manager, report that drivers and trainees often do not even have copies of manuals. There is little means of distinction between the modules themselves as well as between the modules and the practice of driving; a C -- modality is allocated.

4.4 Key findings: a summary of comparison between the CBMT and OJT components of the diploma

The following table depicts the classification indicators and modalities found in each component of the diploma, as well as how each component fits within Bernstein's performance – competence pedagogic models.

Table 9: Summary of classification relations of the CBMT and OJT components of the diploma

Category	Indicator		CBMT component – modality	OJT component – modality
Boundaries between spaces	1	<i>Between the curriculum and site of work</i>	C++	C--
	2	<i>Sites of learning for different rail functioning areas</i>	C++	C+
Fit within Bernstein's pedagogic models			Performance model	Straddles both performance and competence models.
Boundaries between agents	3	<i>Between trainee train drivers</i>	C+	C++
	4	<i>Between educator (either instructional educator or driver tutor) and train driver trainees</i>	C+	C-
Fit within Bernstein's pedagogic models			Performance model	Straddles both performance and competence models.
Boundaries between discourses (curriculum)	5	<i>Between the curriculum of different rail functioning areas</i>	C++	C+
	6	<i>Between 'theory' and practice</i>	C++	C--
	7	<i>Between modules</i>	C+	C--
Fit within Bernstein's pedagogic models			Performance model	Straddles both performance and competence models (but with very weak modalities for 2 indicators leans more toward competence).

An analysis of the classification of the diploma according to the categories of space, agents and curriculum indicate two broad findings:

The driving diploma is a specialised pedagogic space with a strong individualising nature

The CBMT and the OJT components share similar strong to very strong classification on indicator 2 (sites of learning for different rail functioning areas) and indicator 5 (between the curriculum of different rail functioning areas) – indicators that establish train driving as a

distinct field with a specialised pedagogy. The relationship ‘between trainee drivers’ (indicator 3) points to the individualising nature of the pedagogy; regardless of being in the classroom or in the locomotive cab trainees learn or acquire the skills of train driving in isolation from each other.

Two sets of pedagogic practices operate in the diploma – a classroom set of practices with a strong outcomes-based dimension and a modelling set of practices.

In the CBMT component strong to very strong classification is found on indicator 1 (between the curriculum and site of work), indicator 4 (between educator and train driver trainees), indicator 6 (between theory and practice) and indicator 7 (between modules). In other words classification is strong on spatial, agent and curriculum boundaries. Strong classification on these indicators signifies a classroom-based pedagogy with demarcated modules and explicit outcomes. Very strong classification on indicator 1 and indicator 6 establish the classroom or ‘theory’ as separate from work; a traditional form of classroom practice where the educator is the teacher in front of the class (indicator 4). Of particular significance is the very strong classification on the theory–practice indicator where theory amounts to a set of written procedures that need to be learnt in an exact manner. The marked boundary between theory and practice coupled with the competency focus on separate modules (indicator 7) means that trainees are being taught a sequential, step-like procedure to train driving.

In the OJT component weak to very weak classification is found for the same indicators (1, 4, 6 and 7). These blurred boundaries between learning and work indicate a modelling set of pedagogic practices. The space ‘between educator and trainee’ (indicator 4) and the distinction ‘between theory and practice’ (indicator 6) is indiscernible - learning takes place in real time with a real practitioner. In addition, the modules (indicator 7) are invisible in practice.

Overall the classification values of the two sites of practice point to distinct pedagogical practices; where each differentially fits within Bernstein’s two pedagogic models. The CBMT component is a performance model as all seven indicators are strongly classified. The OJT component, on the other hand, straddles both a performance and a competence model as classification strengths vary across different indicators; although four of the seven indicators are weakly classified. In chapter 6 these competence-performance relationships are further analysed in order to establish whether the competence-performance relationship found in the pedagogic outcome of craft is found in the train driving diploma.

The chapter that follows analyses the framing relations in each component of the diploma with a focus on evaluation practices.

Chapter 5: Evaluation Practices

5.1 Overview

This chapter examines the evaluation practices of the national diploma using Bernstein's notion of framing. Bernstein (1996, 2000) argues that evaluation defines what counts as valid realization of the knowledge contained within the curriculum by learners or trainees. Evaluation lies at the heart of pedagogic practice and to transmit criteria "is the sole purpose of the particular pedagogic practice" (Bernstein, 2000:28).

This chapter first presents empirical evidence concerning the nature of train driving in order to demonstrate that it can be considered 'work of risk'. Thereafter the chapter analyses the strength of framing in relation to evaluation in each component of the diploma using Gamble's (2004) coding device (table 3, chapter 3, refers). The analysis examines the knowledge types produced in each component of the diploma.

5.2 Train driving as 'work of risk'

To recap, there are two forms of assessment in the diploma – written tests in the instructional (CBMT) component and an assessment of workplace practice in the OJT component. The risk inherent in train is driving primarily evident in the researcher's observation of two OJT assessments. There are broad two aspects of 'risk' in train driving.

The first relates to train driving as complex, demanding and dangerous. All research participants (in the training centre and the workplace) commented that train operations are characterised by risk. This is exemplified in the following comment made by the training centre manager:

If you move a 120 ton object, in this case a locomotive, I think the very first minute that the wheels start rolling it becomes a danger because if you start moving it and you don't know how to stop it or to control the movement then that in itself can kill people ... And the other thing is if one were only to transport that stuff like coal and iron ore we would understand it but we are transporting people. You take your long distance train²⁷, one coach can take up to 600 people and then there is 11 of them, 600 times 11, it is a number of people. And you are not the only one that is operating this, you are the train driver but there are TCO's [train control officers] and they are human beings like yourself and they can make a mistake. But if a TCO

²⁷ The name of the train is removed for confidentiality reasons.

were to operate a signal let's say now at green or yellow, which is a proceeding aspect and you as a train driver know for yourself that this is actually a mistake because about a minute ago there was another train passing here. Then if you are not alert you will kill yourself simply because you could not pick up that someone else, the TCO, made a mistake. That is why I believe it is a high risk (transcript 7).

In addition, risk pervaded my experience of conducting the field work. Negotiating permission to board locomotives had to be approved at the highest level. During both observed assessments the assessor was very particular to ensure my safety, showing me the correct way to board the locomotive, walk on the upper/outer deck and so on. Upon first entering the depot building the assessor showed me various safety standards charts on the wall. In addition, myself and the assessor were breathalysed and had to wear safety boots and fluorescent safety jackets on the train. Clearly these practices are aimed at limiting risk in the train working environment.

The second aspect of risk relates to lapses in driver judgement. Human-error or errors in judgement are reported by the workplace assessor, the workplace (section) managers and the training centre manager as the primary reason for rail accidents. These participants report that accident numbers in the organisation are currently high. The aim of the training interventions in both the training centre and the depot is to ensure safety; where the ideal driver is one who is able to balance the complexities of the job and handle the train in a smooth, efficient and accident free way. This is demonstrated by the practical assessor's response to a question concerning what the assessment is really testing: "it is all related to safety" (transcript 9).

It can be concluded that the overall purpose of the national diploma is to maintain safety standards. The analysis of evaluation practices that follows reveals that **operating a train safely, minimising risk, is the sole purpose of the pedagogic practice** and evaluation criteria are interpreted in relation to this purpose.

5.3 Framing of evaluation criteria in the national diploma in train driving

This chapter now presents the analysis of framing of evaluation criteria. The assessment methods in each component of the diploma are investigated, followed by an in-depth analysis of the strength of framing of implicit and explicit evaluation criteria. Seven evaluation criteria are used in the analysis, depicted in table 4, chapter 3. The framing strengths for each criterion are assigned according to the table re-depicted below.

Table 10: Framing modalities – evaluation criteria

F++	F+	F-	F--
Explicit control over evaluation criteria		Implicit control over evaluation criteria	
Explicit and specific criteria are transmitted in oral, written or visual form.	Although criteria are transmitted mainly through modelling their presence is clearly signalled.	Criteria are implicit or diffuse and acquirers are not always made aware that they are being evaluated.	Criteria are implicit and diffuse and acquirers are not aware that they are being evaluated.

(Gamble, 2004: 113).

In addition, the knowledge types informing each evaluation criterion are analysed. Using the 'revised taxonomy of educational objectives' (table 5, chapter 3) knowledge is categorised as procedural, factual or conceptual. Tacit knowledge is analysed in relation to the claim made in chapter 2, as an internally held competence that informs all aspects of performance. The sections that follow first examine the CBMT component in relation to the criteria; followed by the OJT component.

5.3.1 Assessment in the CBMT instructional component

Method of assessment

The instructional component of the diploma has two forms of assessment attached to each module; the self-test and the criterion test. The self-test is a pre-assessment designed to assist the trainee prepare for the criterion test. Both assessments are multiple-choice and test transcripts are set out in exactly the same manner although questions are changed for the criterion test.

The trainee must be found competent, in other words attain 80%, on each consecutive module before being allowed to proceed to the next module. Two attempts are allowed for each criterion test; if found not-competent after these attempts the trainee cannot continue and is sent back to the depot. These *stringent specifications* are related to the need to enhance safety. Responding to a question about why these assessment requirements are in place, educator 1 explains:

A train is not like a wheelbarrow, like if you want to stop you can put it down. In a train you will work with people's lives, your train assistants' lives. We have a safety job outside ... If a person cannot determine what a red signal's meaning how can you put that person in a train driver position; so we need to be strict ... We can't pass them and say you almost got 80% let me help you, there is no way we can do that (transcript 3).

A highly structured assessment process

A key feature of the assessment is that it is *strictly time bound*. Both the self-tests and criterion tests are administered on prescheduled dates, with no exceptions. This is evident through an analysis of the course map (appendix 2) as well as educator 1's comment that neither he nor the trainees have control over the pace²⁸ at which modules are taught or assessed; "You are bonded in the boundaries. You need to do this in that time period. Say for the first module they give you 13 days and in that 13 days you need to give everything, must finish off everything" (transcript 2).

The highly structured and explicit assessment methods found in the instructional component are expected within a CBMT model. The *assessment is fore-grounded* and clearly visible to trainees and educators throughout the learning process; it is as though assessment is the sole purpose of the instructional component. The educator 'teaches to the test' and constantly uses the phrase "they will catch you" (field note 1). The trainees view the CBMT assessment as a means to an end. The goal is to pass the tests and get behind the controls of the locomotive; trainees in both focus group interviews claim that the "real learning will happen in the depot" (transcript 5). Both section (workplace) managers share this perspective; with one manager claiming that "they learn the most when they are in the depot; that is the real course" (transcript 8).

The procedural nature of the CBMT assessment mode

Both educators and the training centre manager report that the current assessment system is not working to enhance the safety standards required in the field of train driving despite the strict methods in place. The training centre manager's answer to a question concerning what the criterion test is trying to test is instructive;

I was so hoping that you wouldn't ask me that [laughs]. Let me tell you what the criterion test is supposed to test ... the knowledge gained by the learner over a specific subject; let's say it is protection. And what we would like to see in the criterion test is does he really understand if you are supposed to be out there and protect the train [he] would really know how to; what is

²⁸ This dissertation does not directly focus on pacing but recognises the time-bound nature of the course is a pacing issue, a point at which pacing and evaluation intersect. Educators and trainees have no control over pacing and no control over assessment.

the distance, how many detonators will he use for an explosive train, how many detonators will he use to protect a passenger train, how many detonators will he use to protect an ordinary goods train. But I don't think we very successful with that because learners learn it simply to pass the exam because what we have found in the past, and even just in the immediate past, that a train would fail ...the train assistant will go back and he will afford protection and you will find if you send another locomotive in to go and afford help to the failing train; the train driver will find that there is only one detonator. And one detonator indicates you can still proceed, the only thing that you will be doing is bring your speed down from 90 to 60 km per hour. If you were to ignite two detonators that will tell you, you must stop you can't continue. You must stop and wait there until somebody [comes] and if there is a train in front of you, you would want another train to stop. Then you ask yourself, 'how do this train assistant get it right to put only one detonator there'. We taught him to put two detonators there in the college and he passed it because he marked the right answer – two detonators (transcript 7).

Analysis of assessment documents and participant interviews finds that the CBMT assessment is focused on procedure and isolated bits of knowledge or facts. This is seen empirically through the exclusive use of multiple choice questions as well as the modular nature of assessment.

In the instructional component *multiple choice questions* (MCQs) focus only on procedural knowledge. An analysis of the self-test and criterion test scripts for modules 2 and 3²⁹ indicate that the MCQs relate directly to procedures that need to be recalled in a precise manner. In fact, some of the questions (and possible answers) are produced in the same words as they appear in the module manual; a 'cut-and-paste' exercise. There is no evidence of questions in which the driver is presented with a challenging situation requiring the use of discretion or problem solving in selecting the correct answer.

Below is an example³⁰ of a question taken from a criterion test from one of the train working rules modules; the procedural nature of questioning is evident. At the start of each question the number of possible correct answers is stated in brackets.

²⁹ An additional five module test scripts were reviewed to confirm that the assessment was the same as modules 2 and 3.

³⁰ The module from which this test is taken is not stated and the question number has been changed as the test should not be made public, permission was received to provide this sample question.

QUESTION X (2)

WHICH OF THE FOLLOWING MUST BE COMPLIED WITH WHEN A DRIVER IS AUTHORISED BY MEANS OF A “MULTIPLE AUTHORITY” NAMELY A TELEPHONIC AUTHORITY TO PASS TWO OR MORE CONSECUTIVE SIGNALS AT “DANGER”?

1. The overlap beyond the signal to which the train may proceed, must not be occupied by a train or vehicle.
2. That the line is clear and the points, where applicable, is/are safeguarded by means of the applicable push-buttons and/or reminders.
3. The speed of the train must not exceed 20km/h when the locomotive passes each signal in respect of which the driver already has an authority when he approaches it.
4. If the line is occupied the train-control officer must inform the driver and the latter must proceed cautiously and stop at a safe distance from the train or vehicle/s that occupies or obstructs the line.

An additional finding is that *modularisation encourages procedural learning*. There is no summative assessment of the instructional component; once a criterion test is successfully passed that ‘chunk’ of knowledge is never tested again. This lack of integrated assessment is cited by all research participants (both training centre and workplace) as the most significant weakness of the diploma. In making this claim participants compare CBMT to previous apprentice-like training system. For example educator 2 asserts that;

In the old days you started with the book, let’s say from page 1 to 50, you write a test. Then you go further. The next test would be to page 100 but there are questions in from page 1 to 100 ... Now when they are finished with page 50 and they write the test it is gone ...In other words they don’t even look back. That is why I say the quality of training went down (transcript 6).

The training centre manager claims that once trainees leave the training centre they “throw away” much of what they learn in the modules as they are not able to “see information ... as one complete whole” (transcript 7).

Overall the CBMT assessment mode is highly procedural in nature and limited in its ability to assess anything other than the superficial recall of rote facts and procedures. This rigid method of assessment indicates very strong framing. This framing strength, and emphasis on procedural knowing, is verified in the discussion of CBMT evaluation criteria that follows.

Evaluation criteria in the CBMT component

The following analysis focuses on the strength of framing of criteria 1 to 4 as well as the form of knowledge prioritised in each CBMT criterion.

The modular nature of assessment means that modules translate directly into assessment criteria. An analysis of assessment documents attached to the CBMT modules indicates how the different modules fit within each of the four explicit criteria, depicted in the table below;

Table 11: Module/s attached to each criterion

Criterion	Module attached to criterion
Criterion 1 – adherence to train working rules	Train working rules modules (modules 1-9, appendix 2)
Criterion 2 – knowing the locomotive	Electric locomotive series 6E module
Criterion 3 – safe operation of brake systems	Vacuum-brake and airbrake modules
Criterion 4 - safe train handling	Train dynamics module

Criterion 1 – adherence to train working rules (F++)

The nine train working rules modules make up an immense document covering all the rules that are required to safely operate a train. The rules include; general rules, control of the train over single and uni-directional lines, different systems of train control, the protection of the train and so on. The rules are presented as numbered points and, as stated in chapter 4, the modules read like a policy manual where trainees are expected to learn an explicit set of sequential procedures. The following extract is taken from module 3, element 1:

5. UNIDIRECTIONAL RUNNING LINES (DOUBLE LINES)

5.1 If the signal controlling entrance to a unidirectional section cannot be placed at “proceed”, but there is a white-light or other positive indication showing the line, including the overlap beyond the next signal, to be clear, the train-control officer must complete the relevant portions of SD2 form and hand or send the form [to] the driver as his authority to pass the signal at “danger” and proceed **only as far the next stop signal**.

5.2 Where signal telephones are provided a driver, in the circumstances and on the conditions mentioned in preceding paragraph may be authorised telephonically by means of an authority number to pass the signal at “danger” and proceed **only as far as the next stop signal**.

5.3 Should there not be a white-light or other positive indication that the route beyond the section entry signal is clear, or should the signaling power supply in the section have failed completely or partially, **absolute working** must be introduced between the two stations. “Line clear” must be obtained for each train by exchanging the standard bell signals or, should the tapper bells be out of order, by telephone and the driver authorized by means of an SD2 authority to proceed to the next station.

..... 5.4

It is evident from this extract, and the analysis of all train working rule assessment scripts, that criterion 1 is assessing *procedural knowledge*. There is no room for inference; obtaining the required 80% depends on the precise recall of the miniature of each procedure. Deviations from procedure are not tolerated and a F++ modality is assigned.

Criterion 2: knowing the locomotive (F++)

The electric locomotive series 6E module consists of numerous diagrams of locomotive equipment accompanied by numbered lists naming different parts of the equipment. A brief example from the electric locomotive manual is provided below:

EQUIPMENT	
5. DESCRIPTION	
5.1	The series 6E/6E1 electric locomotive consists of a body mounted on two, four wheeled bogies. Some of the locomotives are modified to adjust to the requirements of the service of which some are re-coded as class 16E and 17E.
5.2	The body is divided into various compartments. A driving compartment, connected with a corridor, is located at each end of the body. Locomotive 16E is provided with one driver's cab only and all relevant equipment in the driver's cab not in use, is removed.
5.3	There are two machine compartments and two high tension chambers. The high tension chambers are sub-divided into separate compartments for switches, resistances and resistance blowers.
..... 5.9	

Analysis of the manual, and assessment documents, shows that evaluation criteria are concerned with the recall of *factual knowledge* such as the parts of a locomotive, the overhead equipment of the locomotive, motors, compressors and so on. No reasons, or theory, about why a particular part functions in a particular way are provided. In other words no principle-based knowledge is evident.

The requirement that the facts (the parts) are recalled in the criterion tests in an exact manner indicates very strong framing (F++).

Criterion 3 – safe operation of brake systems (F++)

In the Bellville training centre trainees are required to complete both the vacuum and airbrake modules. The brakes modules are similar to the locomotive module in that the different components of the braking systems are presented as 'facts'; each of which is explicitly tested in the assessment. Framing is very strong (F++).

Criterion 4 - safe train handling (F++)

The train dynamics module contains the 'science' of handling a train; introducing concepts such as speed, gradient forces and wind resistance. Both educators report that this aspect of the diploma relies on science. Educator 1 explains that this is the reason why trainee train drivers need to have completed school maths and science; indicating that some foundational knowledge of the 'pure' disciplines is required in train driving. However, what is taught is not

discipline-based knowledge but rather an applied³¹ form of the 'science of handling a train'. This is evident in the following extract taken from the train dynamics module. It is important to note that prior to this section in the manual the 'pure science' definition of gravity is provided.

9.1 GRADIENT AND GRADIENT FORCES

Gradient

In railway terminology, the gradient is defined as the constant vertical displacement over the distance travelled.

Gradient Forces

When a gradient is expressed as a ratio for example 1:66, it means that for every 66 measuring units moved horizontally, you move 1 measure unit up....gradients can be expressed as percent or permill. Gravity of course acts on trains. When a train is standing on a gradient, the component of the gravitational force acting along the gradient, is call gradient force. The steeper the gradient, the larger the gradient force, thus [a] steep gradient plays a big role in train handling techniques.

Gradient force is the most important force when calculating the tractive effort needed for a specific load. We know that all objects with a mass is acted upon by gravity. Gravity acts on an object regardless of whether the object is on a level or on a gradient.

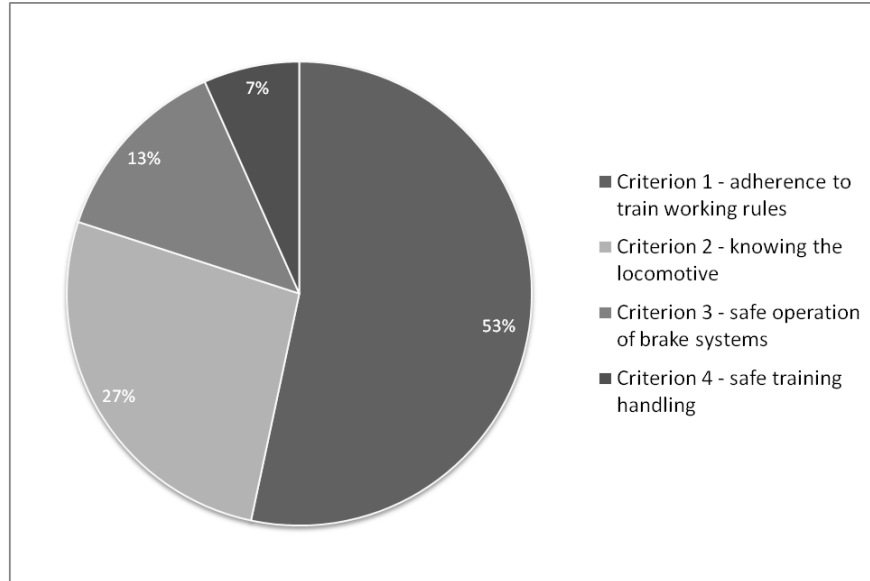
This is the only part of the CBMT component that draws on conceptual knowledge; albeit in an applied form. Using Bloom's taxonomy, the knowledge is defined as conceptual as it operates above the level of facts; there is a recognition of the interrelationships of basic elements (the relationship between gravity and gradients). The manner in which the more conceptually orientated knowledge is tested remains the same and 'concepts' need to be recalled with precision; indicating a F++ modality.

³¹ 'Applied' knowledge selects particular components of scientific knowledge in terms of their application to practice (Gamble, 2009).

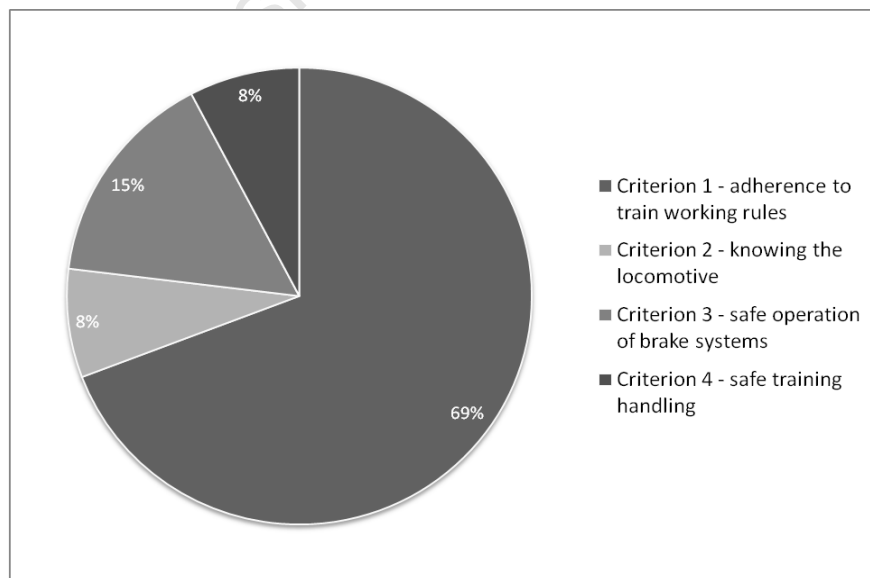
The prioritisation of procedural knowledge in the CBMT assessment

An analysis of weighting in terms of the days allocated, as well as assessment tools dedicated, to the modules indicates which evaluation criteria are prioritised in the CBMT component. The course map (appendix 2) indicates the duration³² of each module as well as the number of assessment tools used in each module. The graphs³³ below depict the weighting; the first graph refers to allocation of days and the second to assessment tools.

Graph 1: Time allocation in days per assessment criterion



Graph 2: the number of assessment tools per assessment criterion



³² Strong framing over pacing (the course is delivered and assessed according to a set schedule) intersects with strong control over criterial rules.

³³ Note both graphs are developed for two braking system modules (as required at the Bellville depot) and no simulation.

Half of the total time (53%) in the instructional component is allocated to criterion 1 (train working rules) and 69% of the total tests are administered in the rules area – making procedural knowledge a significant focus of the assessment. Just above ten percent (13%) of the total time is allocated to criterion 2 (braking systems); 15 % of the total assessment is administered in the brakes area. The time allocated to criterion 3 (locomotive) works out to 27% , with only eight percent of the total tests being conducted in this area. Criterion 2 and 3 concern factual knowledge but while 40% of the time is allocated, only 23% of the tools are testing for factual knowledge. Criterion 4 (train handling³⁴), containing some conceptual knowledge, has the lowest percentages both in terms of time allocation - seven percent, as well as the number of tests conducted – eight percent (this is the same as the percentage for brakes).

Overall there is a marked difference between train working rules (procedural knowledge), with the most days and tools; and train handling (limited conceptual knowledge), with the least days and tools. In other words 46% more time is spent on train working rules than train handling and 61% more assessment tools are used in train working rules than in train handling.

Implicit criteria

Implicit criteria are not evident in the assessment practices of the CBMT component.

In sum

All instructional criteria 1 to 4 are explicit, clearly documented and very strongly framed (F++) and procedural knowledge is the dominant knowledge form.

³⁴ This refers only to the train dynamics module delivered at the training centre and not simulation which takes place at head office after the trainee has exited the training centre.

5.3.2 Practical assessment in the OJT component

Method of assessment

Part-4 assessment involves an assessor coming from head office and accompanying the trainee on a train trip. Two assessments were observed - a conversion³⁵ to a General Electric (GE) locomotive in Worcester (referred to as assessment 1) and a re-licensing assessment in Bellville (referred to as assessment 2). The conversion assessment was of a younger driver with two years experience; she was observed to be nervous throughout the assessment. The re-licensing assessment was of a driver with 20 years experience.

The trainee is allowed two attempts at the part-4 assessment. The assessment is made of up two sections – the locomotive inspection (20% of the assessment checklist) and train handling (80% of the checklist).

The trainee is assessed as competent or not-yet-competent according to a criterion referenced go/no-go checklist; the checklist is lengthy. As illustration the 'GE locomotive conversion' checklist (used in assessment 1) delineates 6 outcomes and 97 go/no go items. Below is an example of one outcome from the go/no go checklist:

OUTCOME 1

B.	EN ROUTE TO – AND ARRIVAL AT LOCOMOTIVES	GO	NO GO
1.	Compiling of high tension safety instructions while examining locomotive and during trip		
2.	Look for red boards/red lights/technicians working		
3.	Safeguarding of locomotive/s		
4.	Checking fuel level		
5.	Checking of fuel emergency trip		
6.	Use of hand rails and steps		
7.	Look for any oil on steps		
	REMARKS		

Despite the numerous items the list lacks depth and the assessor claims it is meaningless to someone who is not an experienced subject-matter expert.

³⁵ Different regional depots use different locomotives, which means that when an employee transfers s/he needs to undergo conversion training and be re-assessed on the new locomotive.

Tacit assessment practices

Tacit assessment practices are evident in observations of both assessment 1 and 2; despite the use of the checklist. After assessment 1 the driver and assessor return to the canteen; and the assessor completes the checklist for the first time. He very quickly ticks various blocks - it is as though he has already completed the form in his head. After the trainee leaves, I ask the assessor how and when he knew she was going to pass. He says he knows “within minutes of taking the train in motion if she will pass”. He says he knows “on approach to the locomotive before a driver starts showing components whether they will pass” (transcript 9). Explaining why he only completes the checklist after the assessment; the assessor says it is “second nature” and he can remember what trainees are able to do or not without the list.

The assessor and the training centre manager (who also conducts practical assessments) both describe using a ‘sixth sense’; and while they cannot account for the ‘sixth sense’ both claim that it is developed from experience and is a necessary part of assessment. The assessor notes that working in a rail operating environment means that he is frequently limited in his assessment of every criterion on the checklist and that he often uses his “discretion”. For example in the observation of assessment 2 the assessor was late; due to his being late the driver and train assistant had already prepared (inspected) the train as the train’s departure cannot be delayed even for an assessment. Yet the driver was found competent despite not being assessed on the locomotive inspection (see criterion 2 below) – clearly the decision of competence is based on implicit dimensions.

In addition, the assessor claims that the knowledge required to operate a train cannot be contained within a single list. He reports that;

Never in your life will you be able to write it all down, it will be staggering document like this [shows a large pile with his hands] if you must mention all the failures and what to look for and procedure and fall back and all this type of things (transcript 9)

In sum; the method of assessment in the OJT component is less rigidly structured than the instructional assessment process (despite clearly specified outcomes) and tacit judgement is evident. However, the safe operation of the train remains paramount and as seen in the discussion of explicit and implicit criteria below, framing of criterial rules is strong.

Explicit Evaluation criteria

As with the instructional component four explicit evaluation criteria are found in the OJT component.

Criterion 1: adherence to train working rules (F++)

Train working rules form part of the go/no-go checklist and adherence to these rules is an explicit requirement of the practical assessment. Rather than listing each rule there is one broad outcome stating that the trainee must drive in a way that obeys rules. The assessor does not directly ask about the rules but if the trainee violates a rule s/he will be rated no-go. In effect what is being tested is the application of *procedural knowledge*. The criterion is clearly documented and the consequence of contravening the rules is unambiguously conveyed by the assessor; a F++ modality is assigned.

Criterion 2: knowing the locomotive (F++)

The locomotive inspection involves the trainee walking around the locomotive (and in the cab itself), opening various compartments and pointing to and naming the parts. The assessor methodically ensures that all parts are identified and does not proceed to another section of the locomotive until he is satisfied that the trainee can name all the parts, and possible faults, in a particular area of the locomotive. The assessor reports that the inspection can take over two hours in the part- 4 assessment of a new train driver. This length of time signals the value placed on knowing the technical functioning of the locomotive. The assessor claims that the trainee requires in-depth knowledge of the locomotive's operation, functioning and possible failures and he is critical of the superficial nature of the current competency assessment checklist. According to the assessor, the checklist does not interrogate failures but just asks the trainee to name a part:

Remember when we go to a checklist - let's talk about the generator of a diesel locomotive or let's use the example of the traction motor. They only mention, you look at the traction motor, look at the traction motor nose-ball; but the traction motor has got certain failures that the driver must be able to identify, a knocking nose with every rotation of the wheel will indicate a broken tooth of a gear wheel; it can cause a locked axle and that can possibly cause major damage to the locomotive or even a derailment. Or a broken tooth on the pinion wheel – a hard knocking noise with a whistle noise together with shorter intervals. You must be able to identify certain things and what is the procedure - to continue out of the area or is it a total failure [requiring the driver to stop]? So there's a lot of things that a driver must do, although they only mention the component there but there're certain questions related to failures to that component as well. There're no questions in the checklist, no questions at all (transcript 9).

The assessor deals with this 'superficiality' by asking questions, for example concerning component failure, not contained within the list.

Factual knowledge is being assessed. The assessor explicitly assesses the accurate naming of parts as indicated in the checklist, as well as functioning of parts; a F++ is allocated.

Criterion 3 – safe operation of braking systems (F++)

The testing of braking systems forms part of the initial locomotive inspection. Again factual knowledge is assessed via practice – the trainee is required to identify the correct brake components, panel indicators and so on. Framing is very strong as in the case of criterion 2.

Criterion 4: safe train handling (F++)

Train handling counts for 80% of the assessment. Train handling refers to the full performance required to safely operate the train. The 'safe train handling criterion' is made up of a number of explicit dimensions detailed in the checklist. They include the correct use of brake applications; accelerating and decelerating depending on environmental conditions to ensure the correct speed is used; identifying and responding to hazards related to the environment, weather and traffic; identifying and responding to traffic control systems (signals) and so on. The assessment of train handling encompasses the trainee's ability to apply *the rules, the technical facts and scientific principles* of train driving; learnt in the training centre. The assessor, however, stresses that the trainee will only be able to operate the train safely if s/he has thorough knowledge of the core scientific principles of safe train handling; such as gradient forces and speed. Failure to understand these concepts (and their effects) can lead to disastrous consequences such as a run-away train.

Safe train handling is an explicit requirement of the practical assessment and a very strong framing value (F++) is assigned.

Implicit evaluation criteria

In addition to the clearly visible aspects of performance (the assessor can instantly see when the trainee has made an error in braking applications and stops past the platform) a number of implicit evaluation criteria inform the assessor's judgement of whether the trainee can safely handle a train.

Criterion 5: confidence in train handling (F+)

Confidence is a key element contributing to safe train operations. The assessor comments that the first thing that he looks at during an assessment is confidence, specifically whether a trainee is comfortable with handling the train at speed. During assessment 2 the assessor clearly felt the experienced driver was confident. At some point the driver did something and the assessor joked “windgat” [daredevil]. A confident driver means that the assessor will overlook minor misdemeanours; the same tolerance might not be shown a new driver. This is not about favouritism but about the driver’s overall confidence in handling the train. The assessor and experienced driver talked to each other in a collegial manner and the assessor did not take on the role of superior during the assessment; in fact at one point the assessor (in role as train assistant³⁶) had to ask the driver how to couple-up some pipes.

In contrast, in assessment 1, the assessor took a more authoritative role with the less experienced driver. He was careful to ensure that she met all the assessment criteria and where necessary he prodded her without ‘giving the answer away’. For example, at one point the trainee looked very nervous as the assessor leaned forward and seemed to raise his eyes, suddenly the trainee opened a compartment in the locomotive cab and named a particular part; the assessor responded “Ek het gewag vir hom hoer” (transcript 9) [‘Listen, I was waiting for it’]. It was the researcher’s impression that such a minor omission would be less significant in the assessment of the experienced driver. In fact the locomotive inspection was not completed by the experienced driver and he was deemed competent on his driving alone; this is not due to favouritism but rather due to the overall confidence with which the driver handled the train.

The criterion of confidence is assigned a F+ framing strength. Although not conveyed to the trainee in a written form the assessor clearly is attending to the issue of confidence; signalled by the difference in his behaviour with the two drivers.

Criterion 6: concentration in train handling (F+)

The assessor claims that concentration is important as a driver needs to work long hours; “you got to have a good concentration level and if your body isn’t capable of working long hours you will never cope with the job”. The assessor reasons that the experienced driver’s ability to concentrate at all times but still hold a conversation is indicative of a good driver. The assessor admits that he cannot easily fail a trainee who he suspects cannot concentrate for long as it is not a stipulated assessment criterion; but at the same time he claims that he

³⁶ The assessor took on the role of assistant as with my presence in the cab there was not space for the assistant.

will never pass a driver that is not safe. The training centre manager (in the role of practical assessor) describes how he makes trainee drivers perform emergency stops which are not part of the assessment. He explains that with “the new appointees I do it all the time just to test their concentration level and I can tell you their level of concentration is minimal, it is minimal”.

Despite not being documented in the assessment checklist the criterion of concentration does inform the assessor’s judgement about whether the driver can safely operate the train. Although implicit framing is strong; a F+ modularity is assigned.

Criterion 7: use of discretionary judgement in train handling (F+)

The ability to make discretionary judgements is reported by all OJT participants as highly valued. For example, after assessment 2 the assessor explained how the driver was planning brake applications very carefully and cited various principles and formulas in relation to speed, gradients, and weight. The planning of the brake applications relates to the weight of the train - when the coaches were empty braking was easy but as the train became fuller the driver was constantly working with the brake. The driver had to be careful because as he was using his brakes more, the brakes were heating up; and because overly hot brakes can fail the use of the brakes involves careful balance and is a matter of judgment. The assessor notes an important evaluation criteria is whether a driver is able to learn from mistakes, correct errors in judgement, and rectify his/her planning. The assessor explains assessing judgement as follows;

... can he rectify if he has done something wrong? You don’t make an immediate recommendation you will tell him, ‘listen please check your speed and your brake applications need some attention’. Then look how the person will rectify that to see, alright, it was just maybe that one area where his focus and attention wasn’t there ...You look at the person’s reaction also, the person might exceed once this thing – you will take note and notify him also, you will say ‘asseblief’ [please], then you see if the person rectifies the problem ... and if he was aware of the problem he had but it was due to just one planning phase that was 30 seconds too late; then you check the reaction and how the person continues after that. Then at the end of the day the person can be found competent yes (transcript 9).

The training centre manager explains that discretionary judgements is not just accepting something (such as a signal) at face value but rather involves thinking critically about whether there may in fact be danger. He notes; “we are saying don’t just accept a green light or a yellow light; obviously one would respond to a red light. But don’t just accept it, question it” (transcript 7).

The use of discretionary judgement was observed during assessment 2 where the driver was driving a route, with passengers, he would not generally drive as a freight train driver. Shortly after we had loaded passengers and left Cape Town station the driver stopped the train at an intersection. He waited for a short while without saying anything; he then turned to the assessor and said the signal indicates he can proceed but previously he was stopped at the same time of day as another train passed. The signal did not change and the driver radioed the train control officer to get confirmation that he could proceed. The driver's smooth attention to driving the train was interrupted and focus was on making a discretionary judgement of risk - the signal needed to be questioned before it was safe to proceed.

The assessor also reports that a key dimension in making subtle discretionary judgements, and the correct diagnostic assessments, is having wide knowledge of the machine; as discussed above.

The ability to make discretionary judgments lies at the heart of train driving and clearly informs the assessment process but is not articulated in the assessment checklist; a F+ modality is allocated.

In sum

The implicit evaluation criteria are strongly framed (F+). The knowledge base underlying the implicit criteria is difficult to put into words and is clearly informed by some form of *tacit knowledge* developed by the train driver over time. This is evident in the difference between the new driver and experienced driver in each assessment. The experienced driver displayed confidence and the ability to make the correct judgement with ease, as opposed to the inexperienced driver who was nervous at times and still needing to accumulate and internalise the experience that enables confidence, concentration and the ability to make discretionary judgements.

5.4 Key findings: a comparison of evaluation practices between the CBMT and OJT components of the diploma

The following table depicts the evaluation criteria and framing modalities found in each component of the diploma. In addition, the kind of knowledge informing each criterion is presented.

Table 12: Summary of evaluation criteria for both the CBMT and OJT components of the diploma

Criterion	CBMT component – modality	Knowledge – base	OJT component – modality	Knowledge – base
1 Adherence to train working rules	F++	Procedural knowledge	F++	Procedural knowledge
2 Knowing the locomotive	F++	Factual knowledge	F++	Factual knowledge
3 Safe operation of brake systems	F++	Factual knowledge	F++	Factual knowledge
4 Safe train handling (train dynamics)	F++	Conceptual knowledge	F++	Conceptual knowledge
5 Confidence in train handling	Criterion not present	-	F+	Tacit knowledge
6 Concentration in train handling	Criterion not present	-	F+	Tacit knowledge
7 Use of discretionary judgement in train handling	Criterion not present	-	F+	Tacit knowledge

The instructional and OJT assessment modes differ significantly both in terms of method of assessment as well as what is prioritised in the assessment – the knowledge produced by the pedagogic practice. Despite these differences strong framing is found in both assessment modes which is linked to the overall pedagogic purpose of promoting safety.

In the CBMT assessment all criteria (1 to 4) are explicit and very strongly framed. The expectation is clear that in order to meet safety requirements the trainee must demonstrate exact 'recall' of all content contained within the four criteria. The modular, time-bound, MCQ assessment, with a clear cut off point of 80%, rigidly tests whether these criteria are met.

Overall the CBMT component values procedural knowledge (criterion 1 - adherence to train working rules) and all other criteria are subsidiary. Factual knowledge is present in criteria 2 and 3 (knowing the locomotive and safe operation of brake systems), yet while a fair amount of time is allocated to factual knowledge, few assessment tools are administered in the area. The criteria emphasising factual knowledge operate at a superficial level and focus on the

rote recall of facts (the locomotive parts). Criterion 4 (safe train handling), which contains some conceptual or science-based knowledge, is minimized.

In the OJT assessment all explicit criteria (1 to 4) are present and very strongly framed. The rules and 'facts' (criteria 1 – 3) taught in the training centre are pertinent to the job and are directly examined to determine whether the driver can handle the train safely. Thus, as with the instructional assessment, both procedural knowledge and factual knowledge are present; although a deeper understanding about what the facts mean is assessed in practice.

Train handling is the focus of the OJT assessment and constitutes 80% of the assessment. Train handling is made up of both explicit and implicit criteria which are simultaneously assessed; unlike the clear demarcation between criteria seen in the CBMT component. Criterion 4 (safe train handling) refers to a set of scientific principles that are needed to operate a train. However, the assessors use a number of implicit criteria (confidence - criterion 5, concentration - criterion 6 and discretionary judgement - criterion 7), that form part of a 'sixth sense', that when combined with the explicit criteria aid the assessors in coming to a determination of able performance. In other words, knowing the scientific principles of train handling as well as having the ability to make rapid decisions in real time (based on the implicit criteria) enables the safe operation of the train. The implicit criteria have a tacit knowledge base acquired through experience - accumulating hours in the cab. Despite their implicit nature the criteria are strongly framed in line with the uncompromising need for safety.

In sum, the CBMT assessment emphasises procedural knowledge and de-prioritises train handling (which makes up only 8 % of the assessment focus). The practical assessment, while requiring the application of procedural and factual knowledge, focuses heavily on train handling (80% of the assessment focus) where the ability to make or adjust decisions under changing conditions is what is being assessed and is dependent on a blend of conceptual and tacit knowledge forms.

This chapter has analysed the knowledge types evident in the national train driving diploma. The implications of these findings (and those presented in chapter 4) are discussed in the conclusion chapter to follow.

Chapter 6: Analysis and Conclusion

6.1 Overview

This dissertation has asked the question:

**Which curriculum and pedagogy leads
to the transmission and acquisition of risk work?**

In addressing this question, a conceptual framework was developed based on a review of literature concerning the nature of risk work (Pye, 1968; Polanyi, 1958) and the pedagogic outcome of craft as risk work (Bernstein, 1996, 2000; Gamble, 2004). The conceptual framework presented the argument that risk work always involves a tension or balance between 'work of certainty' (routinised work) and 'work of risk' (unpredictability). The manner in which 'work of risk' or skilled practice is brought about is through an understanding of the relationship between whole and part – a focal awareness of the purpose of the work and a subsidiary awareness of the events or actions that constitute the work. Developing expertise in any occupation requires an act of integration, where the practitioner comes to understand the pattern making up the whole, and as tacit knowing is developed a skill will come to feel as though it were something habitual or routinised; while at the same time developing a basis for discretionary judgement that comes into play when unpredictable events or consequences come into play. The conceptual framework developed the **hypothesis** that a curriculum and pedagogy that successfully transmits a capacity to handle risk must transmit a combination of the ability to make discretionary judgements as well as the ability to perform routinised action (or the ability for routinised rule following).

The remainder of this chapter will directly address this hypothesis through an analysis of the findings of the two data chapters. The first data chapter examined the structure of the train driving diploma through a comparative analysis of two distinct pedagogic forms - the modelling (OJT) pedagogic mode and CBMT pedagogic mode. The comparison was made using Bernstein's notions of competence and performance models. The second data chapter explored the evaluative practices of the diploma through a direct focus on the framing of evaluation criteria of each pedagogic mode and the knowledge types supported by the criteria in each mode.

The analysis in this chapter first examines whether the craft model can be confirmed as work of risk in an occupation other than craft (train driving). This entails establishing the existence of the internally held competence – externally visible performance in train driving in order to

compare the findings of the current study with Gamble's craft model. The analysis looks directly at whether the skilled performance in train can be stipulated as a combination of routinisation and discretionary judgement. The second part of the analysis explores the knowledge produced (and required) in the train driving diploma - a risk curriculum other than craft.

In conclusion the dissertation presents a conceptual model of the pedagogic outcome of work of risk.

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6.2 Analysis

6.2.1 *The relationship between internal competence and skilled performance: a comparison between the train driving diploma and Gamble's craft model.*

The analysis presented in this section compares the findings of the previous two data chapters with the classification and framing³⁷ relations found in Gamble's study of a craft apprenticeship (referred to as the craft model). This comparison establishes whether the internally held competence-performance relationship underlying the craft model is transmitted in the train driving curriculum and, if so, whether a combination of discretionary judgement and routinised action, is transmitted via the train driving diploma.

An **analysis of the classification** relations of the driving diploma in comparison with the classification found in Gamble's craft model finds both complementary and contradictory relations; as depicted in the following table.

Table 13: A comparison between the classification relations of the train driving diploma and the craft model

Category	Indicator	Craft model – modality	CBMT component – modality	OJT component – modality
Boundaries between spaces	1 <i>Between the curriculum and site of work</i>	C++	C++	C--
	2 <i>Sites of learning for different rail functioning areas</i>	C++	C++	C+
Boundaries between agents	3 <i>Between trainee train drivers</i>	C++	C+	C++
	4 <i>Between educator (either instructional educator or driver tutor) and train driver trainees</i>	C--	C+	C-
Boundaries between discourses (curriculum)	5 <i>Between the curriculum of different rail functioning areas</i>	C++	C++	C+
	6 <i>Between 'theory' and practice</i>	C--	C++	C--
	7 <i>Between modules</i>	C--	C+	C--

The strong classification of the CBMT component indicates a performance pedagogic model in the generic mode (Bernstein, 2000), as it assumes that the 'job' of train driving can be

³⁷ The analysis of framing is limited to evaluation criteria only as detailed in the methodology chapter.

carved into a set of explicit procedures or outcomes and taught 'once and for all'. The performance model does not match the mixed pedagogic outcome of the craft model.

The OJT component, like the craft model, has a mixed pedagogic outcome sharing classification characteristics of both competence and performance models, although leaning toward a competence model with generally weaker classification. This is evident in the match between all the indicators of the craft model and those of the OJT component (with the exception of indicator 1). The difference in relation to indicator 1 is that in the craft model the modelling relationship took place in the trade school removed from factories; while in the driving diploma the modelling relationship is found in the locomotive cab (at the site of work but distinct from other depot functions as outlined below).

An area in which both components of the diploma and the craft model show compatibility is the strong classification on dimensions that refer to the specialisation of voice (indicators 2 and 5). Specialist expertise can only be given in a curricular space that is kept apart from other areas of expertise (Bernstein, 2000). In Gamble's study strong spatial boundaries isolate craft apprentices from the routine practices of factories. Likewise, in the driving diploma the train driver cannot learn to drive a train if s/he is exposed to other functions required in the yard, as to do so means that the driver cannot hear the language (or acquire the internal competence) of train driving. In addition, strong spatial classification between trainees in both components of the diploma matches Gamble's finding of the individualising nature of the craft pedagogy.

A *broad finding* is thus that the relationship between an internally held competence and visible skilled performance is established in the OJT component of the diploma; where a mixed pedagogic outcome together with weak curriculum boundaries parallels the classification values of the craft model. Stated in Gamble's language, the weak internal curriculum boundaries in the OJT component are evidence of an internally held competence tacitly acquired through practice. However, the proceduralised, performance model in the CBMT component has no sight of the relationship.

The **analysis of the framing** of evaluative criteria in the diploma in comparison to the craft model verifies that the competence-performance relationship is found in the OJT component but not in the CBMT component of the diploma. More importantly, an analysis of the evaluation criteria reveals the degree to which the performance of train driving can be described as discretionary judgement plus routinised action. The analysis also enables a description of the internally held competence in train driving.

There is a strong performative requirement of safety in the diploma and the competent trainee is one who is able to understand and internalize this notion. Operating a train safely, demonstrating the correct skilled performance, requires two levels of skills or abilities. The first is to abide by rules and procedures and have an understanding of the technical components of the locomotive; the second is to make judgments in moments of uncertainty or even danger. Strong framing of all assessment criteria is intended to produce these abilities and realize the overall requirement of safety.

This first level of skills (technical know-how and abiding by rules) is brought about by the strongly framed *explicit* evaluation criteria (the specialised pedagogic criteria) found in both components of the diploma; as it is via these criteria that procedural and factual knowledge, relating specifically to the field of train driving, are transmitted. It was found that the predominant aim of the CBMT component is to transmit procedural knowledge. The strong framing of explicit criteria in the OJT component also recognises the need for procedural and factual knowledge as part of the overall aim of maintaining safety (not knowing the meaning of a warning board can have calamitous consequences). However, practical assessors do call for in-depth and holistic knowledge of the locomotive, brakes and rules and probe beyond the items listed in the competency-based checklist. This is discussed further in the analysis of the sequencing of the diploma in 6.2.2.

The finding of strong framing of explicit criteria in both diploma components confirms that procedure, 'work of certainty', is needed in train driving. 'Work of certainty' introduces procedures or habits (in this case primarily the adherence to rules) aimed at minimising driver error. Routinised action in train driving can now be described as *procedural expertise*. In addition, the strong framing of specialised pedagogic criteria combined with the specialisation of voice found in the classification analysis indicates that the procedural element of risk work is always located within the expertise of a particular field –a surgeon and a train driver follow completely different procedures in the course of their daily work but procedures are always present. The term 'expertise' is used to convey a depth of understanding and proficiency that goes beyond the level of procedure, but which relates to an understanding of the purpose of the work as a whole.

The second level of ability or skill, making judgements, leading to the skilled performance is evident in three interconnected *implicit criteria* (confidence in train handling, concentration in train handling and the use of discretionary judgement). The implicit criteria are found exclusively in the OJT component. Discretionary judgement is made up of two broad elements - making diagnostic planning decisions, such as the subtleties of managing braking

systems correctly; as well as constantly assessing potential hazards. Judgements are made countless times in a single train trip and as there is pressure to think quickly in a high risk moment - the ability to make an immediate, reflexive decision is what is being assessed by workplace assessors. The other two implicit criteria, concentration and confidence, inform the ability to make these reflexive judgements. The driver needs to be highly focussed on the task of driving so as to know when a decision is required and confidence enables the driver to act on his/her reservoir of internal experience so as to make the correct judgement. The strong framing of the implicit criteria clearly signal how sound judgement enhances safety. In other words the criteria, despite not being included in the assessment checklist, clearly do inform the assessor's decision of whether the trainee is able to demonstrate the appropriate skilled performance. There are correlations between these criteria and the implicit criteria found in Gamble's model, discussed below.

The three implicit criteria reveal that a tacit rule underlying the ability to use discretionary judgement in train driving concerns evaluating risk. In fact the entire skilled performance is enabled through a deeply held awareness of risk - every act in train driving, whether routine or spontaneous, is informed by the need to minimise risk and maintain safety. Thus the internally held competence in train driving can be described as a '*continuous diagnosis of risk*', which informs both procedural expertise as well as discretionary judgement.

In sum, the strong framing in the diploma of all assessment criteria and the existence of a set of implicit criteria is what establishes the discretionary judgement and procedural expertise as the skilled performance of train driving. This matches the strong framing found in the craft model. Although the exact nature of the criteria may differ in the craft model, the manner in which the criteria produce the skilled performance of risk work is the same. The following table summarises the strong framing found in the train driving diploma and the craft model.

Table 14: A comparison between the framing relations of the train driving diploma and the craft model

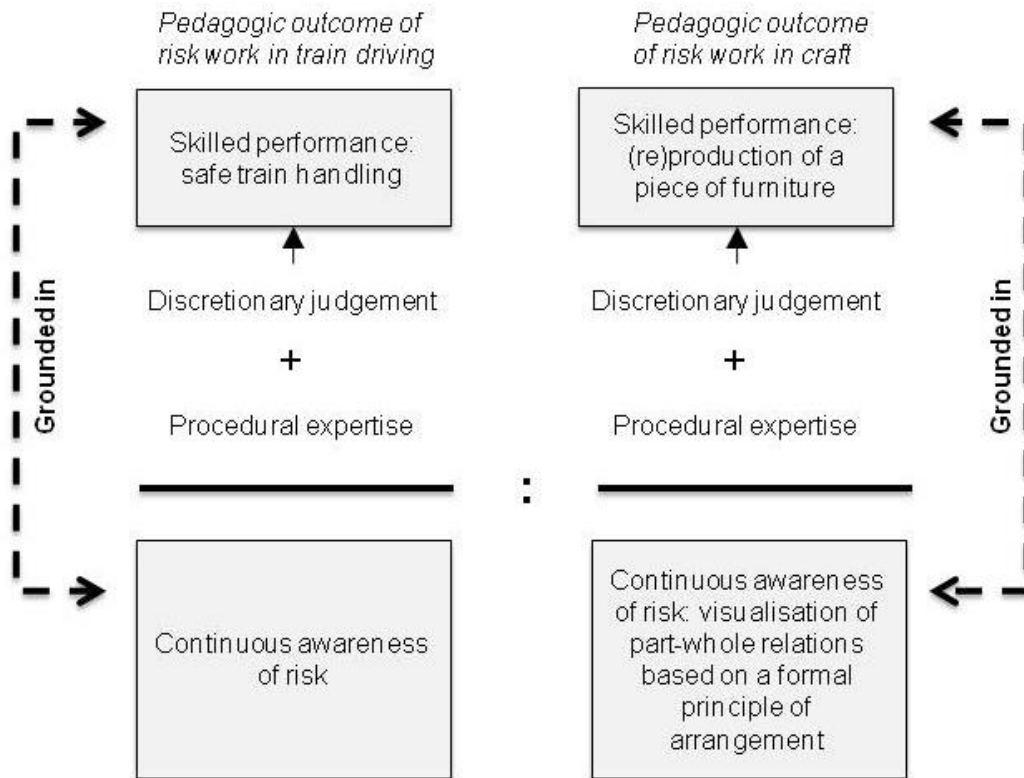
Evaluation criteria	Craft model modality	CBMT modality	OJT modality			
Explicit (specialised pedagogic) criteria	Criteria of accuracy and precision	F++	Adherence to train working rules	F++	Adherence to train working rules	F++
			Knowing the locomotive	F++	Knowing the locomotive	F++
	Criteria of tool usage and materials	F+	Safe operation of brake systems	F++	Safe operation of brake systems	F++
			Safe train handling (train dynamics)	F++	Safe train handling (train dynamics)	F++
Implicit criteria	Criteria of readiness	F+	Not present	-	Confidence in train handling	F+
			Not present	-	Concentration in train handling	F+
			Not present	-	Use of discretionary judgement	F+

Strongly framed explicit criteria (specialised pedagogic criteria) are found in both components of the driving diploma as well as the craft model. The explicit criteria in the craft model place clear expectations on the craftsman and bring about the procedural expertise of cabinet making; for example inaccurate measurements are not tolerated. However, in the craft model, the criteria are conveyed in a modelling relationship as opposed to the step-by-step list of requirements or procedures as is the case in the CBMT component of the diploma. As repeatedly seen in the data, explicit performance requirements in the OJT component are conveyed within a modelling pedagogic form but assessed according to criterion-based checklist; although the assessor uses the list in a flexible manner.

It is at the level of implicit criteria that the OJT component and Gamble's craft model show the most compatibility. The implicit criteria are not evident in the CBMT component. To recap, in Gamble's craft model the internally held competence refers to the capacity for visualisation of a relationship between part and whole; which represents a formal but embodied form of principled knowledge. In Gamble's model the strongly framed implicit evaluation criterion of 'readiness' leads to the capacity for visualisation. Readiness is never stated in words but the master-trainer clearly knows (seen via the strong framing) when the apprentice has grasped the principle of arrangement and has mastered the craft. In the present study, the overall purpose of the work (the visible skilled performance) is about the *safe handling of the train* which involves both procedural expertise and the constant use of discretionary judgement. The performance can only be judged able when the internal competence, a '*continuous diagnosis of risk*,' is mastered.

The following diagram illustrates the empirical findings of the pedagogic outcome of risk work in train driving in relation to the pedagogic outcome of risk work in craft.

Figure 2: The pedagogic outcomes of risk work in the train driving and craft curricula



A central finding of this dissertation is that the OJT component of the diploma confirms the craft model of 'work of risk'.

The analysis now closely examines the pedagogic practice of the diploma to offer an account of the knowledge that is produced in each component of the diploma and importantly what forms of knowledge (other than principled craft knowledge) are required in the risk curriculum.

6.2.2 The knowledge produced in the train driving diploma: an analysis of pedagogic features.

There is a distinction between the curriculum's intention to transmit the ability to handle risk and what the pedagogic practice is doing in reality. The finding of the internally held competence-performance relationship in the OJT component opens some possibility of the pedagogic practice being able to deal with risk but, taken as a whole, the study finds that the diploma is unable to transmit the pedagogic outcome demanded in safe train handling. This is so because the realization of the curriculum intention is constrained by the dominance of a CBMT system which severs the internal competence-performance relationship. Overall two pedagogic features of the diploma sever the competence-performance relationship; firstly, the selection and sequencing of different forms of knowledge and, secondly, the assessment mode. The analysis of the different forms of knowledge found in the diploma is the point at which the findings in relation to classification and framing intersect. Classification shows what forms of knowledge are evident and framing of evaluation criteria reveals how the knowledge is prioritised within the curriculum.

Strong classification at the inter-curricula level produces a **pattern of sequencing** that severs the relationship between internal competence and performance. This strong classification means that 'theory' or instruction is delivered and once complete the trainee exits the training centre and starts the OJT. The result is that the theory-practice relationship, which is recognised as vital to any vocational curriculum, is not realised (Barnett, 2006, Gamble, 2006; Young, 2006; Wheelahan, 2007, 2010). Essentially what is being kept apart in the diploma curriculum is the knowledge produced in the classroom/instructional component and the knowledge produced in practice. An analysis of selection and sequencing at the intra-curriculum level (within each component of the diploma) reveals that a different form of knowledge is predominant in each component.

Turning first to the knowledge produced in practice - within the modelling relationship of the OJT component it is the experience of the driver tutor (similar to what Gamble (2004) refers to as the master craftsman's 'privileged repertoire') and not the modules that form the basis of learning. The knowledge transmitted through this modelling relationship is a principled (albeit tacit) knowledge form with a relational logic. It is this relational rather than sequential or procedural logic that supports the ability to make discretionary judgements in a range of different risk moments. However, the current difficulty is that the OJT component is

sequenced right at the end³⁸ of the diploma by which time opportunities to make important connections between theory and practice (actually making the decisions) are lost.

Turning next to theory or instruction; it is the dominance of procedural knowledge within the CBMT component that negates the possibility of a competence-performance relationship. Strong classification between the CBMT modules results in each module being taught as a stand alone module according to a predetermined sequence. There is no relation between the procedural modules (the rules) themselves or between the procedural modules and factual knowledge modules (the technical aspects of the locomotive and brakes systems) and conceptual knowledge modules (the scientific principles of train operations). The primary focus of the CBMT component is the relay of a set of sequential procedures.

The greatest constraint on the realisation of the competence-performance pedagogic outcome in the driving diploma is the finding that conceptual knowledge (the scientific principles realised in train handling) and factual³⁹ knowledge (technical terminology) are marginalised within the CBMT component and not formally included in the OJT component. Train driving *does* have a scientific knowledge base; shown empirically through the diploma entry requirement of school mathematics and science, the existence of scientific principles in the train dynamics module (albeit minimised and delivered in an applied⁴⁰ form only) as well as the practical assessors' emphasis on scientific principles. The focus of the practical assessment is train handling and the practical assessors reason that the ability to handle a train safely is fundamentally dependent on grasping the key scientific principles upon which train handling is based. In other words, a sound awareness of scientific principles underpins the driver's ability to make discretionary judgements –the driver cannot make the correct decisions to stop a run-away train if s/he does not understand the concepts of speed and gradient forces. In addition with regard to factual knowledge, application in a risk environment necessitates more than merely repeating a list of names; and as claimed by the practical assessors, in-depth technical knowledge is required by the driver to engage with the ever-changing and complex machine that s/he is driving.

³⁸ It is recognised that the trainee will enter the diploma with some prior experience due to the requirement of having first been a train assistant, where some practical experience was gained through observing the driver. This, however, is not considered sufficient to prepare the trainee for the complex process of decision making.

³⁹ Factual knowledge is not 'pure' scientific knowledge but according to Bloom's taxonomy is strongly linked with (or it parts of) scientific knowledge as it refers to "the basic elements that students must know to be acquainted with a discipline to solve its problems".

⁴⁰ The space limitations of this dissertation do not allow for the examination of applied knowledge; a brief definition was offered in chapter 5. 'Applied' knowledge selects particular components of scientific knowledge in terms of their application to practice (Gamble, 2009).

Furthermore, although instructional educators and practical assessors disagree concerning the depth of 'theory' to be included in the curriculum; they all recognise that trainees require foundational concepts from the start of their training and that these concepts cannot be gained through experience but need to be delivered in a formal teaching environment.

The **assessment mode** is the second pedagogic feature severing the competence-performance relationship. The CBMT assessment in the classroom component is also designed to operate in the OJT component and hence has a significant pedagogic effect on the diploma as a whole. The problem with the CBMT assessment is its attempt to stipulate complex work in a sequential way. In this regard the modular nature of the curriculum and multiple-choice questions (MCQ) methodology of the assessment system are inappropriate. There is no link between the answer provided to a multiple-choice question and the situations trainees face in practice. Workplace practitioners' are vociferous in their criticism that the modular system leads to rote learning that cannot be applied in practice. The dangerous practice of only placing one detonator behind a broken down train was cited as just one example of the kind of practice that results from rote learning of procedures that do not connect with risk assessment in practice. Referring to the definition of procedural expertise above, as a proficiency that goes beyond the level of procedure; a clear finding is that CBMT assessment is unable to assess the procedural expertise required in train driving.

The OJT assessment currently plays a vital role in the diploma. The data shows that it is the prioritisation of the implicit dimensions of training driving which allows sight of the whole and that ultimately brings about the 'continuous diagnosis of risk'; which in turn supports the development of the skilled performance. The difficulty is that the OJT assessment practices are continually thwarted by the CBMT system because of the requirement to use the criterion-based checklist. If it were not for the experienced assessors' use of tacit knowledge assessment practices the process would bear no relation to important implicit abilities, such as the use of discretionary judgement. At a more basic level, the use of the CBMT checklist in the practical assessment refers exclusively to explicit criteria – the procedural expertise. However, we have seen that the CBMT assessment is not able to assess this procedural expertise. Again it is the experience of the assessor, and his flexible use of the checklist that truly enables the assessment of procedural expertise and discretionary judgement.

In sum, the analysis has shown that the principled-knowledge base of the occupation of train driving is not sufficiently elaborated and integrated into the curriculum due to the sequencing arrangements and the model of assessment. What results instead, is a dilution of conceptual knowledge and an over-proceduralisation of the curriculum leading to a sequential logic that

devalues the relational logic necessary for problem diagnosis and problem solving based on discretionary judgement.

In the final section, the dissertation uses the above findings in relation to the train driving curriculum to develop to conceptual model of the pedagogic outcome of work of risk.

6.3 Conclusion

The first conclusion of the dissertation is that it confirms Gamble's empirical study of craft as 'work of risk'. Craft is a work of risk, because the outcome of any craft depends on the craftsman having developed a particular internalised competence which allows a skilled performance; thus placing the outcome of craftwork within the control of the craftsman (and not in the realm of procedural work of certainty). The empirical scrutiny of a completely different skilled occupation – train driving; provides strong evidence that an externally visible performance embedded in an internally held competence (the visualisation of the whole) is required in the transmission of the ability to handle risk. On this basis it can be argued that the internally held competence - skilled performance relationship will be different in different occupational settings, according to the performances or internal competences demanded and produced by the specific occupation; but *the relationship is necessary to skilled work*. In methodological terms this finding increases the generalisability of Gamble's craft model.

Second, and tied within the first conclusion, the visible skilled performance in risk work is found to be a combination of discretionary judgement and routinised action (or procedural expertise). It is only through the combination of these abilities that the risk-certainty tension can be conveyed in the pedagogic practice of skilled work. In addition, the internally held performance of risk work is found as 'the continuous diagnosis of risk'. This confirms the hypothesis on which this study was based.

The third conclusion is that not all skilled work can be based solely on the tacit visualisation of principled knowledge in craft. In the case of train driving applied theoretical principles need to be transmitted and acquired *explicitly* in order to provide a basis for risk diagnosis. There is a requirement for conceptual knowledge that goes beyond craft. It follows that not all curricula dealing with risk are based solely on modelling pedagogic practices, but rather on a mix of classroom practice and workplace experience, in which case the theoretical principles (conceptual knowledge) are largely transmitted and acquired in the classroom.

Finally, this study has shown that a competency-based modular training logic cannot transmit risk as it has no sight of the overall purpose of the work. Conversely, it leads to an over-proceduralisation that undermines the very basis of skilled performance.

These conclusions can be formalised into a conceptual model of risk work that has wider general salience. The conceptual model of the *pedagogic outcome for 'work of risk'* comprises a visible skilled performance (of procedural expertise and discretionary

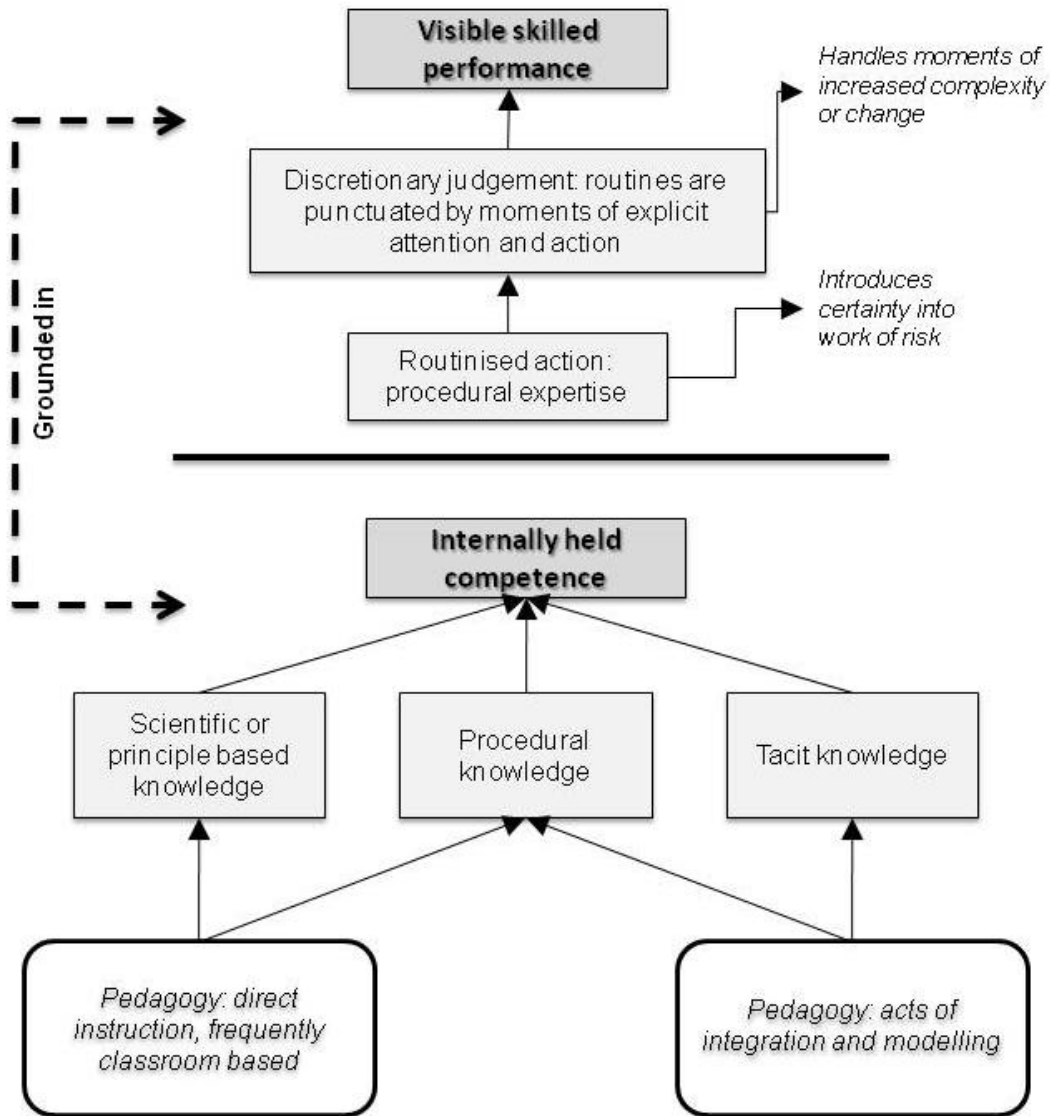
judgement) that is grounded in an internally held competence (characterised by three kinds of knowledge - conceptual, procedural and tacit).

This model adds conceptual and procedural knowledge to the focus on tacit knowledge in Gamble's competence-performance formulation. The addition of conceptual knowledge does not contradict Gamble's notion of tacit knowledge. Rather, conceptual knowledge stands alongside tacit knowledge as being of the same principled nature but explicit rather than tacitly held. This model leads to a recognition of *knowledge-based expertise as the hallmark of skilled and professional work*. It is the emphasis on principled knowledge with a relational logic (whether in the form of the principled knowledge of craft or a more formal form of conceptual knowledge) that differentiates skilled from semi-skilled work; which follows sequential procedures.

The pedagogies of the three knowledge kinds are as follows: conceptual knowledge is learned through direct instruction, frequently in the form of classroom teaching; procedural knowledge is learned through direct instruction as well developed through modelling and tacit knowledge is developed through acts of integration and modelling.

The model specifies that the visible skilled performance in risk work involves procedural expertise (which introduces certainty into 'work of risk'). When procedure is interrupted by moments of uncertainty, explicit attention and action is required. In these moments, discretionary judgement is needed to handle increased complexity or change. The conceptual model of the pedagogic outcome for work of risk is represented in the following diagram:

Figure 3: Diagrammatic representation of the conceptual model of the pedagogic outcome of 'work of risk'



Limitations of study and areas for future research

In the methodology chapter it was argued that while a single case study does not necessarily ensure generalisability, this limitation can be addressed through the rigorous application of a previously developed theoretical model in an unrelated field. As we have seen, the finding of the necessary relationship between an internally held competence and a visible skilled performance in risk work shows theoretical generalisability. To further strengthen the claim of theoretical generalisability, the model should be tested in other occupational fields. A future area of research could be to test the model in a risk environment characterised by greater complexity, such as the training of professionals. This study has intentionally focused on knowledge and has presented a conceptual model of the forms of knowledge that are

required for a curriculum to be able to transmit risk work. However, the manner in which the three forms of knowledge in the model can be combined is not directly addressed. Future areas of study could focus on pedagogic features such as the sequencing and pacing arrangements of the risk curriculum; examining how the shift between classroom practice and modelling should be structured.

It is hoped that this study contributes to a better way to construe the complexity that belies the frequently static representations of vocational education and training as only concerned with procedures.

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University of Cape Town

Appendices

Appendix 1: Unit standards for the National Diploma: Train Driving (Mainline Operations; level 5)

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SOUTH AFRICAN QUALIFICATIONS AUTHORITY

REGISTERED QUALIFICATION:

National Diploma: Train Driving (Mainline Operations)

SAQA QUAL ID	QUALIFICATION TITLE			
57407	National Diploma: Train Driving (Mainline Operations)			
ORIGINATOR		ORIGINATING PROVIDER		
SGB Transport and Logistics Operations				
QUALITY ASSURING BODY				
TETA - Transport Education and Training Authority				
QUALIFICATION TYPE	FIELD	SUBFIELD		
National Diploma	Field 11 - Services	Transport, Operations and Logistics		
ABET BAND	MINIMUM CREDITS	OLD NQF LEVEL	NEW NQF LEVEL	QUAL CLASS
Undefined	240	Level 5	NQF Level 05	Regular-Unit Stds Based
REGISTRATION STATUS		SAQA DECISION NUMBER	REGISTRATION START DATE	REGISTRATION END DATE
Reregistered		SAQA 0160/05	2009-09-01	2012-06-30
LAST DATE FOR ENROLMENT		LAST DATE FOR ACHIEVEMENT		
2013-06-30		2017-06-30		

In all of the tables in this document, both the old and the new NQF Levels are shown. In the text (purpose statements, qualification rules, etc), any reference to NQF Levels are to the old levels unless specifically stated otherwise.

This qualification does not replace any other qualification and is not replaced by any other qualification.

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of the National Diploma: Train Driving (Mainline Operations) NQF Level 5 is to provide service excellence with a focus on safe working in the field of rail transport services. The qualification is the more advanced of a series of qualifications that will form the learning pathway for persons in the rail transport industry (train driving). The qualification provides the broad knowledge, skills and values needed in the rail transport industry (train driving) and will facilitate access to and mobility and progression within the industry.

A learner certified as competent against this qualification will be able to move rail vehicles and/or commodities (freight/passengers) from one point to another safely on rail under any condition in

accordance with company-specific policies, procedures and instructions.

Rationale:

In South Africa, government has set as a priority the shifting of as much traffic as possible - both freight and passenger services - from road to rail. A move such as this necessitates the timeous development of the critical competence of train driving that will make the shift of traffic from road to rail sustainable.

Transport services and persons operating within this industry will benefit from this national qualification and its competence standards, which are instrumental to the development and recognition of the foundational, practical and reflexive competence (applied competence) needed to render effective and efficient rail transport services. These services are essential in and to the following domains:

- Enabling the economy.
- Enabling the rendering of passenger services.
- Tourism.
- Linking South Africa with the rest of the SADC Region by rail, which enables cross-border economic activity.
- Enabling vital social services.

Central to the qualification is the development of a culture of safe working.

LEARNING ASSUMED TO BE IN PLACE AND RECOGNITION OF PRIOR LEARNING

The following is the learning assumed to be in place for the National Diploma: Train Driving (Mainline Operations) NQF Level 5:

Learners accessing this Diploma in Train Driving (Mainline Operations) will have an FETC 4 qualification, inclusive of Mathematics and/or Science.

- Standard: Sign on and off for locomotive crew.
- Standard: Apply first aid protocols.
- Standard: Identify, report and react to hazardous material sub-standard conditions.
- Standard: Demonstrate knowledge and understanding of HIV/AIDS in a workplace and its effects on a business sub-sector, own organization and a specific workplace.
- Standard: Compile Trains.

Recognition of Prior Learning (RPL)

Learners who already work in the train driving industry and who believe that they possess the competencies to enable them to meet all of the outcomes listed in the unit standard will be able to present themselves for assessment against the unit standards of their choice. Once found competent, these learners will be certified as competent and credited.

RPL will allow for accelerated access to further learning and gaining of credits towards a qualification. All RPL is subject to quality assurance by the ETQA and is conducted by a registered assessor.

Access to the qualification:

Access to this qualification is governed by the carefully defined learning assumed to be in place (FETC 4 qualification, inclusive of Mathematics or Science). The learning assumed to be in place forms the essential basis for acquiring the competence described in this qualification and is not intended to be used as an artificial barrier to learning opportunities.

Learners must possess the medical and physical capabilities prescribed in terms of the relevant legislation and policies governing rail transport workers.

Learners who can provide evidence of the learning assumed to be in place, and who possess the necessary medical and physical capabilities may access the qualification or its unit standards.

RECOGNISE PREVIOUS LEARNING?

QUALIFICATION RULES

- All fundamental unit standards: 23 credits
 - All core unit standards: 181 credits
 - Select at least 1 electric locomotive: 24 credits
 - Select at least 1 train brake system: 12 credits
-
- Total: 240 credits

Train Drivers operate in different contexts. Providers of these qualifications need to ensure the competence required is provided in these contexts.

In a specific operational environment it is normally expected from Train Drivers to operate different trains in one shift, which requires qualifications on different locomotives.

Apart from obtaining the generic competencies required for Train Drivers (fundamental and core unit standards) the learner has specialisation options made possible through appropriate combinations of Electives.

The core unit standard "Apply Road Knowledge principles" will be a prerequisite for performing actual train driver duties in the operational environment. Due to the various topographies of different routes it is impossible to split the contents of the Road Knowledge Principles. Road knowledge learning periods reflected are the minimum allowed due to the complexity of different rail networks and will depend on the learner's ability to cope with the complexity thereof.

The learning period applicable to the core unit standard "Convey Passengers or Freight by Rail" is determined by the minimum trips (Seventy trips) a learner needs to complete before application for certification. During this learning period the theory with regards to the operation instructions, locomotive, brake system (s) and principles of Train Dynamics needs to be integrated within a practical environment.

The practical exposure is required to enable a learner/Train Driver to make intelligent decisions with regards to train - and locomotive handling to ensure safe movement of the train on rail.

The following define the rules of combination (core streams) with regards to the different core unit standards required for this qualification.

Note: To obtain this qualification, learners must complete all the unit standards in the fundamental category and are required to do all credits from the core and titles include:

A combination of locomotives.

At least one Electric and one Dual Locomotive Unit Standard, or Steam and one Diesel Unit standard (where applicable), and:

- Vacuum Brake System.
- Convey Passengers or freight by rail.
- Apply Road Knowledge Principles.
- Apply Train Dynamics and train handling techniques.
- Operate and regulate the safe movement of locomotive.
- Operate safely under or with high voltage equipment.

The practical exposure is required to enable a learner/Train Driver to make intelligent decisions with regards to train and locomotive handling to ensure safe movement of the train on rail. Learners need to select a minimum of 12 credits from the elective category.

EXIT LEVEL OUTCOMES

On achieving this qualification, the learner will be able to:

1. Prepare the locomotive for service, operate and regulate the locomotive /locomotive consist safely under/with high voltage equipment.
2. Inspect train load consist and test the operation of different train brake systems.
3. Safely operate and regulate different trains on different topographical conditions within different

train control systems whilst complying with principles of safe movement on rail.

4. Operate applicable train brake system within company specific instructions and manufacturers specifications.

5. Apply communication protocols related to various designations, descriptions and company terminology.

The critical cross-field outcomes are integrated with the unit standards and assessment criteria of each unit standard were drafted to include assessment of the degree to which critical cross-field competence has been attained. Learner competence can be assessed against a single unit standard or, in cases where learners are enrolled on a skills programme, competence may be assessed against the relevant cluster of standards on which the skills programme is based.

ASSOCIATED ASSESSMENT CRITERIA

1.

- The preparation of the locomotive/ locomotive consist is executed safely under/with high voltage equipment in accordance with company procedures and manufacturers specifications.
- The operating and regulating of the locomotive/ locomotive consist is executed safely under/with high voltage equipment in accordance with company procedures and manufacturers specifications.
- The correct method for identification, reporting and reacting to sub-standard conditions is followed in accordance with company specific procedures and instructions.
- The correct utilizing of different train control systems and. the correct application of principles of safe movement on rail are complied with in accordance with company specific instructions.

2.

- The trainload consist is inspected safely and correctly in accordance with company specific instructions.
- The operation of the applicable brake system is correctly tested in accordance with company specific procedures/instructions and manufacturers specifications.

3.

- The correct train dynamics and train handling techniques are applied in accordance with company specific instructions.
- The small-scale graphical displays, audible and visual indications of locomotive gauges, indicators and environmental conditions are correctly interpreted according to company specific instructions and manufacturers specifications.
- The correct method for identification, reporting and reacting to hazardous material sub-standard conditions is followed in accordance with company specific procedures and instructions.
- Passengers or freight is safely conveyed by rail in accordance with the principles of safe movement on rail and in accordance with company specific instructions.
- The correct utilizing of different train control systems and. the correct application of principles of safe movement on rail are complied with in accordance with company specific instructions.

4.

- The audible and visual indications of locomotive gauges, indicators are correctly interpreted.
- The application and recharging of the applicable brake system is executed within company specific instructions and manufacturers specifications.
- The application and recharging of the applicable brake system is executed in accordance with different topographical conditions.
- The operation of the applicable brake system is correctly tested in accordance with company specific procedures/instructions and manufacturers specifications.
- The correct method for identification, reporting and reacting to sub-standard conditions is followed in accordance with company specific procedures/ instructions and manufacturers specifications.

5.

- The communication protocols related to various designations, descriptions and company terminology are correctly applied in accordance with company specific instructions.
- Diagnostic and analytical evaluation techniques are correctly applied in accordance with company specific instructions.
- The correct principles, methods and techniques when communicating to various designations, descriptions and company terminology are utilized in accordance with company specific instructions.

Integrated assessment:

Learning, teaching and assessment are inextricably linked. Whenever possible the assessment of knowledge, skills, attitudes and values shown in the unit standards should be integrated.

Assessment of the communication, language and mathematics should be conducted in conjunction with other aspects and should use train-driving contexts wherever possible.

Assessment should cover all specific outcomes, embedded knowledge and critical cross-field outcomes. The latter should be integrated with the assessment of specific outcomes and embedded knowledge.

Assessors should conduct formative and summative assessment and assess for applied competence (i.e. integration of practical, foundational and reflexive competence).

- Ongoing / Formative Assessment:

This kind of assessment work will typically take place during training and merely serves to guide the learner towards full competence.

Assessment can be done in any agreed upon method of assessment of the knowledge required to perform the various competencies.

- Summative Assessment:

To be allowed access to the final qualifying assessment a learner must show that she/he has reached a level of overall integrated competence. The elements of importance here are overall abilities, problem solving capability and safe working. In addition assessors should be satisfied that the learner has achieved that level of competence to be able to take charge of any aspect of train driving.

The learner's ability to demonstrate competence against a particular unit standard, under real-life working conditions and in the presence of an assessor, will be assessed. The summative assessment can also be used as a diagnostic assessment tool aimed at identifying the learner's skills gaps.

- Workplace Assessment:

Workplaces can be used for assessment purposes provided that the appropriate facilities, tools, equipment, and support systems are available and accessible to both the assessor and the learner. The train driving industry requires workplace assessment for the following reasons:

- > Assessment needs to occur in a familiar environment so that the learner is not asked to cope with different equipment and a strange environment at the time of assessment.
- > Assessment needs to take place at a time and venue mutually agreed to by the assessor and the learner.

INTERNATIONAL COMPARABILITY

Benchmarking was done Burlington North Railway Academic Science School (BNRAS) Canada and Australia Rail. These Rail Road Operators were chosen for their similarity to the railroad setup within RSA.

- BNRAS does not have Unit standards to compare with. However the learning programmes correlate with the contents of learning programmes and syllabi in the SA context.

- Different profiles exist in the rail transport environment within Canada, for example:

- > Locomotive engineer vs. Train Driver in RSA.
- > Train Dispatcher vs. Train Control Officer in RSA.
- > No profile exists for a Train Assistant as within RSA.

- Australia was also in the process of generating Unit Standards for the Train Driver environment and requested us to send them draft versions of the Unit Standards related to the qualification Train Driving (Mainline Operations) to assist them in the generating process. The only profile, which correlates with RSA, is the so-called Train Driver. Train Assistant does not exist.

- Tranzrail, New Zealand registered recently their unit standards, of which some of them are similar to the unit standards within this qualification; however, specific outcomes differ in totality.
- The qualification was also benchmarked against Scotland and the United Kingdom Qualification Authorities.
Scotland, Ireland and the United Kingdom make use of the same qualification database with mutual understanding agreements.
There is however, no correlation between Train Drivers in South Africa and with those mentioned. No operating system unit standards exist as well as train brake systems and locomotives for utilization by train drivers.
- Over and above the benchmarking to establish the international comparability of the qualification and unit standards, local and international research around risk factors that influence safe operation has been consulted to ensure the qualification adequately emphasises human factors impacting on safe working. The research consulted as part of the local benchmarking effort is the 1996 SPAD (Signals Passed at Danger) Report commissioned by Spoornet. This research studied the basic causes of SPADs and related incidents, with a focus on the role of the driver. The SPAD Brief was formulated as follows: "To comprehensively investigate and to report with recommendations, on the underlying causes and contributory factors which may lead to the impairment of train driver / crew functioning at critical moments during the shift cycle." In the course of this research a close working relationship and understanding had been established with the following international parties:

- > Dr George Kuehn (Rail Simulation and Training Institute, Chicago).
- > Simon Folkard (Medical Research Council, Sheffield University, UK).

Local and international academic and research institutions at the time of the research expressed interest in Spoornet's SPAD investigation. The research provided this standards generating body with valuable insight, which is reflected in the qualification and unit standards for train drivers.

ARTICULATION OPTIONS

The qualification lends itself to both horizontal and vertical articulation possibilities, which allow mobility and progression for the learner. Horizontal articulation possibilities lie with other qualifications at the same level in the learning area of transport and logistics operations such as:

- FETC: Transport Management at NQF level 4, ID 49489.
- FETC: Pipeline Operations NQF level 4, ID 49553.

Vertical articulation possibilities can be achieved by continuing up the learning pathway in transport management and generic qualifications such as BA Generic.

MODERATION OPTIONS

The moderator has the following functions:

- Monitoring and evaluating the standard of all summative assessments in terms of the ETQA policy.
- To review both substantive and process related matters in the case of an appeal against an assessment decision.
- Maintaining standards by exercising appropriate influence and control over assessors to ensure good standards of practice.
- Exercising a moderation function in case of a dispute between assessors, or between any assessor and learner.
- Giving written feedback to Workplace Education and Training Committees the relevant ETQA and when required.
- Submitting reports to the ETQA in terms of the ETQA policy.

CRITERIA FOR THE REGISTRATION OF ASSESSORS

Assessors must meet the following requirements:

- Anyone assessing a learner or moderating the assessment of a learner against this qualification must be must be registered with relevant ETQA.
- Assessment and moderation of assessment will be overseen by the ETQA according to the ETQA's

policies and guidelines for assessment and moderation; in terms of agreements reached around assessment and moderation between ETQA's (including professional bodies); and in terms of the moderation guideline detailed immediately below.

- Anyone wishing to be assessed against this Qualification may apply to be assessed by any assessment agency, assessor or provider institution that is accredited by the ETQA for this purpose.
- Anyone assessing a learner against this qualification must be trained, qualified, certified and re-certified in accordance with validation regulations relevant to the specific qualification and registered with the relevant ETQA. Be fluent in the official language in which the learner prefers to be assessed.
- Be able to adequately record assessment responses, minutes of meetings between learner and assessor and any other information that may be needed for the performance of moderation activities.
- Be a fair and approachable person and have time available for assessment activities.
- In the event of an outstanding appeal against an assessment decision, (lodged with the ETQA), the assessor will not be allowed to perform further assessments.

NOTES

N/A

UNIT STANDARDS:

	ID	UNIT STANDARD TITLE	OLD LEVEL	NEW LEVEL	CREDITS
Core	230414	Inspect train load consist and test operation of train brake systems	Level 4	NQF Level 04	14
Core	230402	Operate a train equipped with a vacuum brake system	Level 4	NQF Level 04	12
Core	230421	Operate safely under/with high voltage equipment	Level 4	NQF Level 04	4
Core	230418	Operate, and regulate the safe movement of locomotive/s	Level 4	NQF Level 04	10
Core	230404	Apply road knowledge principles	Level 5	New Level Assignment Pend.	52
Core	230420	Apply train dynamics and train handling	Level 5	New Level Assignment Pend.	8
Core	230410	Convey freight or passengers by rail	Level 5	New Level Assignment Pend.	57
Core	230407	Operate diesel electric locomotive class GM/GE including all upgrades	Level 5	New Level Assignment Pend.	24
Fundamental	14522	Analyse and explain the impact of one`s personal interactive style on one`s relationship with a client	Level 5	New Level Assignment Pend.	6
Fundamental	8647	Apply workplace communication skills	Level 5	New Level Assignment Pend.	10
Fundamental	8648	Demonstrate an understanding of professional values and ethics	Level 5	New Level Assignment Pend.	4
Fundamental	7866	Plan, organise and monitor work in own area of responsibility	Level 5	New Level Assignment Pend.	3
Elective	230405	Operate electric locomotive class 5E1	Level 4	NQF Level 04	24

		including all upgrades			
Elective	230417	Operate a train equipped with a pneumatic controlled air brake system	Level 5	New Level Assignment Pend.	12
Elective	230416	Operate electric locomotive 7E 25 kV alternating current and all upgrades	Level 5	New Level Assignment Pend.	24
Elective	230403	Operate electric locomotive class 11E 25 kv alternating current	Level 5	New Level Assignment Pend.	24
Elective	230409	Operate electric locomotive series 10E including all upgrades	Level 5	New Level Assignment Pend.	24
Elective	230415	Operate electric locomotive series 14E including all upgrades	Level 5	New Level Assignment Pend.	24
Elective	230419	Operate electric locomotive series 6E including all upgrades	Level 5	New Level Assignment Pend.	24
Elective	230408	Operate electric locomotive type 9E 50 kv alternating current including all upgrades	Level 5	New Level Assignment Pend.	24
Elective	230412	Operate electric motor coach train set 3 kV direct current type 5M2A including all upgrades	Level 5	New Level Assignment Pend.	24
Elective	230401	Operate electric/diesel locomotive 38 class series including all upgrades	Level 5	New Level Assignment Pend.	24
Elective	230413	Operate electronically controlled pneumatic train air brake system	Level 5	New Level Assignment Pend.	12
Elective	230406	Operate pneumatic two-pipe multiple release train brake system to facilitate safe movement on rail	Level 5	New Level Assignment Pend.	12

LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION:

NONE

PROVIDERS CURRENTLY ACCREDITED TO OFFER THIS QUALIFICATION:

This information shows the current accreditations (i.e. those not past their accreditation end dates), and is the most complete record available to SAQA as of today. Some Quality Assuring Bodies have a lag in their recording systems for provider accreditation, in turn leading to a lag in notifying SAQA of all the providers that they have accredited to offer qualifications and unit standards, as well as any extensions to accreditation end dates. The relevant Quality Assuring Body should be notified if a record appears to be missing from here.

NONE

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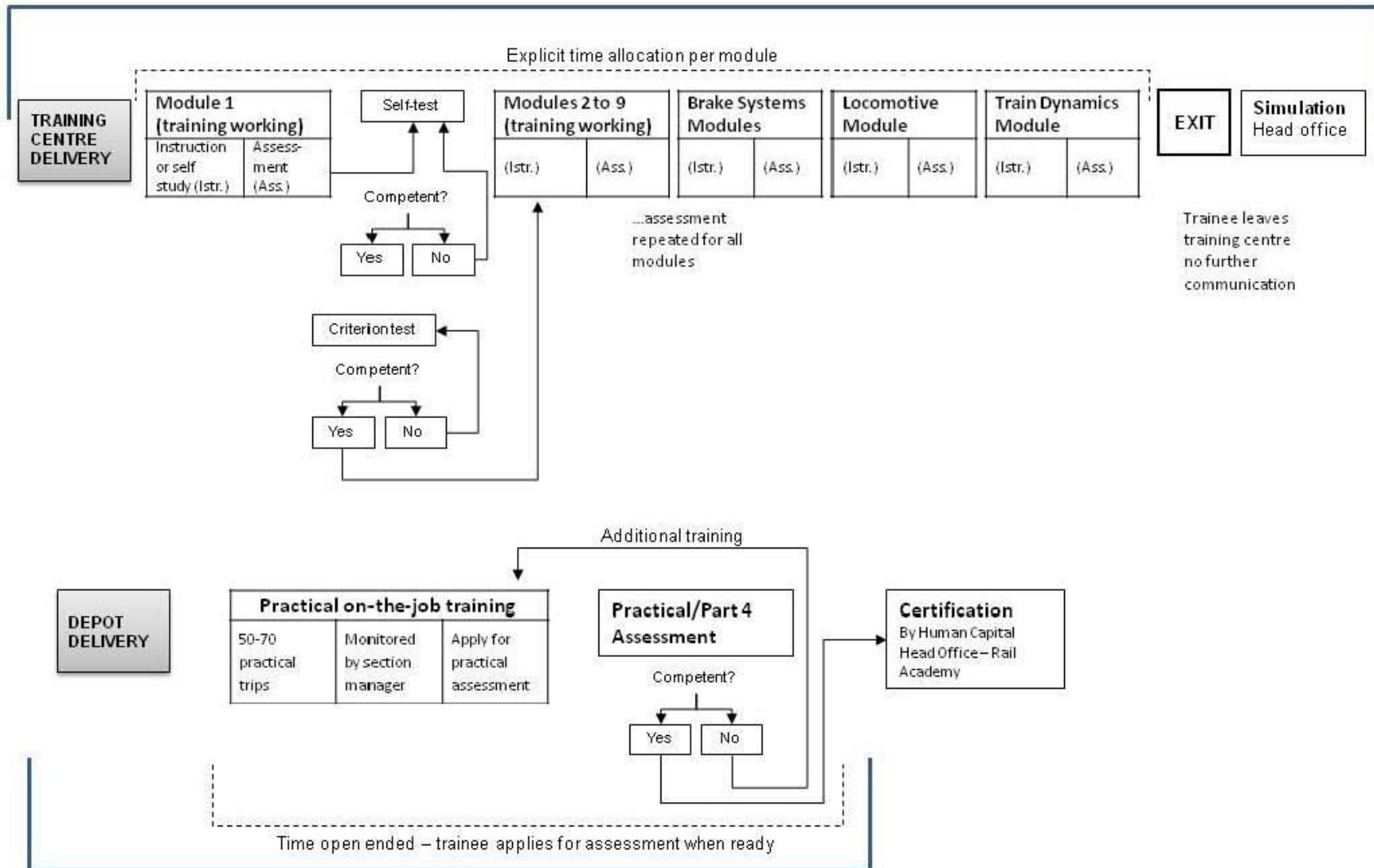
Appendix 2: Course map for the National Diploma: Train Driving (Mainline Operations)

Part 1 to 3: the modules	Duration in Days	Number of assessment tools		Revision days
		Self test	Criterion test	
Induction	Days not stated			
<i>Rules</i>				
Module 1: General rules	13	2	2	2
Module 2: Control of trains over uni – and bidirectional lines by means of the colour-light signalling system	6	1	1	1
Module 3: Double lines	4	1	1	1
Module 4: Protection	4	1	1	1
Module 5: Single lines – general	6	1	1	1
Module 6: The telegraph order system of train control	3	1	1	1
Module 7: The Van Schoor train token system	2	1	1	1
Module 8: Control of trains by means of the radio train order system	2	1	1	1
Module 9: Track warrant system	Not stated	Not stated		
<i>Brake systems</i>				
Air	5	1	1	1
Vacuum	5	1	1	1
<i>Basic Locomotive</i>				
Locomotive GE/6E	20		2	3
<i>Training Handling</i>				
Train Dynamics	5	1	1	1
Simulator (simulator training falls within part 1-3 of the diploma but is not a course module and not administered by training centre).	4		3	1

Note: the duration includes assessment

Appendix 3: Diagrammatic overview of the National Diploma: Train Driving (Mainline Operations)

PARTS 1 - 3



Appendix 4: Document data sources

Document sources
CBMT / Instructional component
Course map of diploma (schedule of training)
Unit standards
Manuals of all modules (do I need to state by number)
Assessments of modules 2 and 3 (self test and criterion test)
Assessments answer forms modules 2 and 3
Review of assessment tools of all modules
OJT component
Practical training contract
Notice for practical training
Activities list for practical training
Pre-assessment notification
Request for practical training
Practical assessment of locomotive personnel GE locomotive – additional, conversion, refresher
Practical assessment of locomotive personnel -part 4 / validation / refresher
Memorandum train driver conversion (notice that the driver may operate a specified train following successful assessment).

Appendix 5: Interview and Observation Data Sources

Interview data sources and collection methods

Data Source	Data collection method	Data reference
Training centre manager and tour of training centre	Unstructured (introductory) interview.	Transcript 1
Educator (instructional) 1	Unstructured (introductory) interview	Transcript 2
Educator (instructional) 1	Face-to-face interview (semi-structured)	Transcript 3
Trainee group 1	Group interview (semi-structured)	Transcript 4
Trainee group 2	Group interview (semi-structured)	Transcript 5
Educator (instructional) 2	Face-to-face interview (semi-structured)	Transcript 6
Training centre manager	Face-to-face interview (semi-structured)	Transcript 7
Section (work-based) manager in Worcester	Face-to-face interview (unstructured)	Transcript 8
Part 4 (practical) assessor	Face-to-face interview (semi-structured)	Transcript 9
Section (work-based) manager in Bellville	Face-to-face interview (semi-structured)	Transcript 10

Observation data sources and collection methods

Data Source	Data collection method	Data reference
Observation of module x	Unstructured observation	Field note 1
Observation of module x	Unstructured observation	Field note 2
Observation of Part 4 (practical) assessment in Worcester (assessment 1)	Unstructured observation	Field note 3
Observation of Part 4 (practical) assessment in Bellville (assessment 2)	Unstructured observation	Field note 4

Appendix 6: Adapted classification indicators

(A) Adapted spatial boundaries indicators

Gamble's indicator		Indicator for train driving diploma
Inside and outside the workshop→	Indicator 1: Between the curriculum and the site of work
Trade workshops	} →	Indicator 2: Sites of learning for different rail functioning areas.
Between different sections of the trade school		
Between apprentices	→	Indicator 3: Between trainee train drivers
Between master-trainer and apprentices in the workshop	→	Indicator 4: Between educator (either instructional or driver tutor) and trainee train drivers
Between master-trainer and apprentices outside the workshop	→	No relevant to this study.

Re-categorised as **agents** in my study

(B) Adapted curriculum boundaries indicators

Gamble's indicator		Indicator for train driving diploma
Between the curriculum for each trade	→	Indicator 5: Between the curriculum of different rail functioning areas
Between school woodwork and cabinet making		Not relevant to this study.
Between 'theory' and practice	→	Indicator 6: Between 'theory' and practice
Relation between modules	→	Indicator 7: Relation between modules
The distribution of tasks and activities		Not tested in this study.

Curriculum and teaching decisions

1. Who makes decisions about how the curriculum is designed and what is involved in the design process? What is your involvement as facilitator?
2. How are decisions made about what is included (the content) in the curriculum? How does this differ for the training centre and workplace components?
3. Are there any aspects of the course that you feel are not relevant or necessary or perhaps there are areas that you feel should be included that are not? Explain giving examples.
4. How much flexibility do you have in delivering the curriculum? For example, things may be set out in the curriculum but you as facilitator may make choices to adapt as you teach. How do you do this and what does this involve?
5. Is there a logic of how the course is put together / ordered – for example what comes first? Please explain.
6. A related question – why are the modules divided up in the way that they are?
7. What are the challenges you as facilitator face in teaching the course?
8. What is the timeframe of the course – what you do when (both training centre component and workplace)?
9. How is it decided how time will be allocated, for example which modules will take longer – why?
10. What role do you as facilitator play in making timing decisions and how do you make these decisions?
11. With the move to the use of unit standards have you seen changes in the course (way it is designed or delivered), give examples? What are the implications of this change?

Assessment

12. Can you explain how the assessment takes place (both training centre component and workplace)? How do the two types of assessment differ?
13. Who is involved in assessment? What kinds of decisions are made about assessment?
14. What is the assessment attempting to test (probe: recall of procedures, problem solving ability / application)?
15. How are the different types of assessment (training centre versus workplace) weighted?

Teaching role and train driver role

16. Why did you change from being a train driver to an educator? You still drive trains now – but how do you see yourself more as an educator or more as a train driver?
17. What is your relationship like with the depot etc now that you are an educator – has it changed and in what ways?
18. How is the course the same or different to what you know and do as a train driver? In other words can you see links (or gaps) between the course and you experience as a train driver? Give examples.
19. How when you are delivering the course do you work with your own experience as driver as well as learner experiences as train driver assistants?
20. From your experience of the field what would you do differently in the course?

Links between training centre delivery and workplace

21. How is the training centre component of the course linked with the workplace component? Describe the relationship between these components (looking for integration/ not)?
22. How formal are the links – is it structured in the course design or something that happens more ad hoc – maybe due to relationships you or other trainers have with the depot.
23. Tell me about your relationship with the depot and the trainer driver mentors. How regularly do you speak to them and what kinds of things do you speak about (for example giving and receiving feedback on the course or learner progress)?
24. Seeing the course it was not always clear to me how the learner would make links with the workplace? For example they may be able to learn the content of the module but how do they go about applying this learning?
25. How do you understand theory and is there a theory of being a train driver? If so what?
26. A related question, is there a theory component in this course (e.g. the training centre component)?
27. I imagine that being a good trainer driver involves being able to think on your feet and use your discretion if necessary. Is that taught in the course and if so where and how is it taught?
28. At the same time looking at the course materials it is obvious that there are many procedures and rules, is this how you would describe the course (as about learning the rules) or do you see it involving more – something bigger?

Appendix 8: Trainee group interview schedule

Curriculum and teaching decisions

1. Are there any aspects of the course that you feel are not relevant or necessary or perhaps there are areas that you feel should be included that are not? Explain giving examples.
2. Do you see a logic in the course is put together / ordered? If so, can you explain what you see as the logic?
3. How does the timing of the course work for you – the amount of time spent on each module, the amount of time in the class versus the depot?
4. Do you have any say in how the course was run? (And do you think you will have more or less say when you go into the workplace)? Explain.

Assessment

5. Can you explain how the assessment takes place (both training centre component and workplace)? How do the two types of assessment differ?
6. How do you experience the criterion tests and how do they relate to what a train driver actually does in the workplace?
7. What do you think the assessment is testing (e.g. your recall of procedures, your problem solving ability / application)?
8. What do you think is more important the training centre or the workplace assessment?

Teaching role and train driver role

9. How is the course the same or different to what you know and do as a train driver assistant? In other words can you see links (or gaps) between the course and your own experience as a train driver assistant? Give examples.
10. Do you feel the course actually describes what it is like to be a train driver and what you have to do? [Do you recognize the work you do (and that you see train drivers doing) in the course?] If not, why not – what is different or left out?
11. Do you feel there are opportunities for you to bring your own experience into the learning environment (especially the classroom part that you have been doing so far)?
12. From your experience of the field what could be done differently in the course?

Links between training centre delivery and workplace

13. How is the training centre component of the course linked with the workplace component? Describe the relationship between these components (looking for integration/ not)?
14. When I sat in some sessions it seemed that a lot of the course is about rules and procedures, how do you relate this to what you are expected to do as a train driver? [What about discretion and thinking on your feet?]
15. I imagine that being a good train driver involves being able to think on your feet and use your discretion if necessary. Is that taught in the course and if so where and how is it taught?
16. How do you understand theory and is there a theory of being a train driver? If so what?
17. A related question, is there a theory component in this course (e.g. the training centre component)?

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History

1. Can you describe the history of training and how it has changed over time; are you able to name the different types of training?
2. What are the benefits and weaknesses of each system – the old course and what you have now?

The course

3. Can you describe the job of train driving?
4. What kind of training is needed to prepare drivers for this job, how does the current train driver qualification go about doing this?
5. What role does the training centre play in training a driver and how important is this?
6. Is there a logic to how the course is put together / ordered – for example what comes first? Please explain.
7. A related question – why are the modules divided up in the way that they are?
8. With the move to the use of unit standards have you seen changes in the course (way it is designed or delivered), give examples? What are the implications of this change?
9. How is the course the same or different to what you know and do as a train driver? Give examples.
10. From your experience of the field what would you do differently in the course?
11. How do you understand theory and is there a theory of being a train driver? If so what?
12. The practical assessor and drivers were talking about having an instinct for the job, being a natural – something that is difficult, but not impossible to teach. How does the course attempt to do this?

Links between training centre delivery and workplace

13. How is the training centre component of the course linked with the workplace component? Describe the relationship between these components?
14. Tell me about your relationship with the depot and the trainer driver trainers / section managers. How regularly do you speak to them and what kinds of things do you speak about?
15. Seeing the course it was not always clear to me how the learner would make links with the workplace? For example they may be able to learn the content of the module but how do they go about applying this learning?

Assessment

16. You are the assessor for the criterion tests for each module? How does this work, how is it designed?
17. In your opinion, does the assessment work?
18. Overall what is the assessment trying to evaluate – what do you want the trainee to be able to know or do? In other words, what are you looking for when seeing whether someone will make a good driver?
19. What role do the different types of assessment (training centre versus workplace) play and how are they weighted?
20. Can you provide a sample assessment question that can be used in my research?

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Appendix 10: Practical assessor interview schedule

Initial questions for practical assessor

[These questions were prepared prior to the observation of practical assessment 1. Additional questions were asked during the observation]

1. How do you understand evaluation and your role as assessor?
2. How do you know when a trainer driver (especially a novice train driver) is ready for assessment?
3. Explain the assessment process and what you as assessor are looking for in the trainee?
4. In what way does the evaluation taking place in the workplace fit with the assessment of the training centre?

Follow up questions for practical assessor

[These questions served a guide only and were asked after the second observation].

1. When we last met you said the problem in the company is a lack of discipline; can you explain this?
2. Noticed you went through the assessment criteria very briefly with the trainee at the beginning of the assessment, why is this?
3. How are the criteria used?
4. You were a driver, then facilitator and now assessor – how are the roles different?
5. I noticed in the last assessment if the trainee was hesitant or getting something wrong you would give her clues or help her along a bit; can you explain why you do this?
6. What would make you 'fail' someone?
7. When we last met you spoke about the current theoretical training not being as strong as it was in the past because they write off modules and also there is not enough detail (you gave the example of how they now don't need to know how a particular component of the train works). Can you explain this a bit more?
8. You said the practical training is just as strong as it was in the past – please explain this a bit more?
9. I noticed that the checklist has a list of outcomes that you tick at the end of the assessment. Why do you not complete the list during the assessment?
10. When you assess someone what are you really looking for? What do you want to see to know that the person is a good driver?
11. How does the trainee know when/ whether you have passed or failed him/her?

12. After the last assessment you told me that you know within minutes of the trainee taking the train in motion whether the trainee is going to pass. You spoke about this being a sixth sense; can you explain this a bit more?
13. How does the sixth sense relate to the assessment checklist?
14. Can you talk about the match or mismatch between the 'books' and what is done in practice? For example, I have been told that driver tutors say to trainees that "the book is lying".
15. It is stated in the memorandum that the training will be done in phases and the trainee will be assessed on each phase before s/he can go to the next phase – what are these phases?
16. You and the driver being assessed referred to the issue of instinct in train driving and whether this instinct can be taught; can you discuss this a bit more?

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