Chapter 10
Inscribing Professional Knowledge and Knowing

As Merlin Donald (2001) argues, almost any advance in human intellectual enterprise – such as the development of navigational techniques that allowed great ocean voyages to be made, and accounting techniques that made international banking possible – can be traced back to certain, sometimes very small, even trivial, symbolic innovations which, after many refinements, now allow people to think and work in ways that were previously unthinkable. However, the invention of symbolic technology is not enough to achieve change in human practices. In order to explore the full potential of symbolic inventions, both individually and collectively, human minds have to learn 'countless invisible habits' to use symbols effectively (p. 307).

Symbolic competence is a well-recognised part of 'workplace literacy', and practitioners, in every professional field, are expected to master a certain set of inscriptional skills needed to carry out their activities and engage with collective work effectively (Belfiore, Defoe, Folinsbee, Hunter, & Jackson, 2004). Furthermore, as knowledge workers, professional practitioners are expected to be adept at managing their knowledge by creating a range of inscriptions that allow retrieval and application of this knowledge quickly and effectively when needed (Eraut, 2009; Schwartz, Varma, & Martin, 2008). However, as Eraut (2009) notes, how this is done in practice can be uncertain.[1] This is not to say that professionals do not create written records or students do not engage in symbolic learning tasks. (One could even claim the opposite – students spend too much of their learning time

[1] As Eraut (2009) says, 'All vocational and professional practitioners are knowledge workers, who are expected to recognise or find out what knowledge is most relevant for their current learning goals, track down that relevant knowledge and make appropriate notes for speedy retrieval at a later date. Information from several sources may be required and, if concept maps of the topic and/or notes on its evidence base are constructed as these investigations proceed, they will greatly enhance the usefulness of their inquiry. Managing one's knowledge adds value to the time spent acquiring and refining it, but this approach is rarely found in practice. Hence it is important to develop a repertoire of these approaches to knowledge representation' (p. 6).

L. Markauskaite, P. Goodyear, *Epistemic Fluency and Professional Education*,
Professional and Practice-based Learning 14, DOI 10.1007/978-94-007-4369-4_10

producing inscriptions, such as essays, reports and other literary artefacts.) What we would argue is that the symbolic nature of professional work in workplace settings and learning in higher education is largely taken for granted and the nature of inscriptional work is therefore quite a mysterious part of professional teaching and learning. How *do* students learn the inscriptional competences needed for their daily professional work and for workplace innovation?

This chapter and the next focus on the role of inscriptional competences in professional practice and look more deeply into the 'representational' qualities of epistemic artefacts used and produced in professional learning in higher education. We ask the following questions:

- What kinds of knowledge, experiences and 'slices' of the real world get inscribed in the artefacts created on the boundaries between higher education and the workplace?
- What kinds of signs are used to encode knowledge?
- What kinds of decoding do these inscriptions afford and restrict?
- What enables epistemic artefacts produced by students to function as professional inscriptions and also as learning artefacts?

We address these questions from two perspectives: functional and semiotic. In this chapter, we take the functional perspective and discuss *what* inscriptions *do* and *how* they obtain their particular roles in practice. In Chap. 11, we take the semiotic perspective and explore *what* inscriptions *mean* and *how* they mean what they mean. That is, by combining two perspectives, we explore how inscriptions, through their pragmatic and semiotic features, become part of a larger epistemic conceptual fabric that provides the foundations for actionable knowledge and knowledgeable action.

We use the word 'inscriptions' to refer to representations of phenomena recorded in some artificial memory medium, as with notches on a tally stick, print on paper or text on a computer screen (Roth & McGinn, 1998).[2] Our perspective on inscriptions in intellectual activity brings together cognitive, social and material views.[3] Inscriptional work (inscribing) is taken as an important *form of*

[2] More specifically, by 'inscriptions', we refer to a broad class of human memory representations that draw on human capacities to utilise symbolic technological devices in an external memory storage system. Inscriptions, therefore, are different from other human memory representations (such as mimesis and speech) which draw only upon human biological capacities to use the body and brain as (internal) memory storage systems. In this sense, the former representational system is technological, while the latter representational systems are biological (see Donald, 1991, 2001; and Chap. 5).

[3] *Traditional cognitive* (*information processing*) *views* of inscriptions primarily associate inscriptional capabilities with the ability to establish connections between individual mental processes and external symbolic expressions. The *social view* of inscriptions and inscriptional capabilities focusses on the capabilities needed to participate in socially shaped inscriptional practices (Roth & McGinn, 1998). The *enactive material view* moves away from the arbitrary meanings of inscriptions and looks for the source of meanings and, therefore, capabilities in a dense structural coupling between the human mind and its engagement with the physical world (Malafouris, 2013).

thinking which draws on the human capability to establish dynamic connections between the capacities of the internal memory system, affordances of the external inscriptions and engagement with the physical world more generally.

In this chapter, our aim is to make the representational qualities of professional inscriptions, and inscriptional practices in professional work and learning, more visible. We are interested in how professional inscriptions function in professional work and learning and how students learn the capacities for inscribing that are vital for knowledgeable work and innovation. We look into the properties of inscriptions, the nature of inscriptional work and the relationships between inscriptions created and professional action. More specifically, we discuss what gets inscribed and when, what the purposes of these inscriptions are and how the symbolic artefacts that have been created relate to 'real-time' knowledgeable action.

We have two complementary objectives. First, we articulate some traditional functional qualities of inscriptions and inscriptional practices. For this we draw on the literature about inscriptions in scientific knowledge work and in professional practice. Second, we reveal some often obscured, yet critical, features of inscriptions and inscriptional work within professional learning and innovation that have important implications for how inscriptional work is seen and taught in higher education. For this, we draw on some examples from our empirical studies and extend them with our reinterpretations and reframing of inscriptional work from the enactive knowledge perspective.

We show that professional innovation and knowledgeable action are deeply intertwined with inscriptional work. We make four main arguments:

1. Inscriptional practices in professional work are multiple and heterogeneous. Thus, becoming 'inscriptionally literate' requires mastering skills to create, switch between and join together a broad range of inscriptions and ways of inscribing.
2. Inscriptional tasks in learning settings are different (on a deep epistemic level) from the inscriptional tasks in workplace settings (i.e. they are idealised and epistemified).
3. Canonically, the role of inscriptions in knowledge work and innovation has been associated with the view that inscriptions are tools for creating and representing *order in the world*. In contrast, we argue that one additional – and indeed the main – inscriptional skill for professional knowledgeable action and innovation is learning to *inscribe work*.
4. In the past, inscriptions that support work have been seen either from 'the person's perspective' (i.e. practitioners', insiders', first-person singular perspectives) or from 'the system's perspective' (i.e. neutral observers', outsiders', third-person plural perspectives) (Norman, 1991). We extend these views with an additional 'enactive' perspective. We *reframe* how inscriptional capabilities are usually seen and taught in higher education. We argue that for creating inscriptions of actionable knowledge and for knowledgeable work, students should learn to see their inscriptional work in these 'enactive' terms.

In Sect. 10.1, we offer a broader review of why inscriptions and inscriptional skills matter in professional work. In the next Sect. 10.2, we review common (functional) properties of inscriptions that make knowledge work possible. In Sect. 10.3, we turn from inscriptions themselves to the knowledge and skills involved in inscriptional work. In Sect. 10.4, we look more closely at 'inscribing for professional learning'. We step away from the theoretical argument and describe a case that illustrates some common features of inscriptions and inscriptional work in professional learning. In Sect. 10.5, we return to the theoretical argument and discuss how knowledge related to professional work itself gets inscribed (i.e. in contrast to the inscription of knowledge about the phenomena in the world on which the work is operating). In Sect. 10.6, we share some empirical results from our studies that illustrate how students learn to inscribe work and learn through inscribing work in higher education. In Sect. 10.7, we link the insights from the foregoing sections and start to draw some pedagogical implications. In Sect. 10.8, we introduce the enactive perspective for reframing inscriptional pedagogies in higher education.

10.1 Inscriptions in Professional Work and Learning

The theme *inscription*, as the central element of knowledge practices, emerged in science and technology studies (STS). Latour and Woolgar (1979) in their book *Laboratory Life* illustrated the case that much of the knowledge work in scientific laboratory settings is carried out by producing, moving around and sharing various documents such as research papers, preprints, drafts, research protocols, presentations and the outputs of automatic inscriptional devices that transform 'pieces of matter into written documents' (p. 51). Many subsequent studies of scientific work have also shown that one cannot understand scientific knowledge work without understanding how individual scientists, scientific laboratories and larger disciplinary groups shuffle around and manage inscriptions (Knorr Cetina, 1999; Rheinberger, 1997).

Inscriptions and inscriptional work play a significant role in a number of professional domains (Eraut, 2009; Goodwin, 1994; Goodyear & Steeples, 1998; Hall, Stevens, & Torralba, 2002; Sarkkinen & Karsten, 2005). For example, various studies of skilled vision in professions such as Medicine, Biology and Law are arranged around shared representations, and effective participation in such work and discourse depends on the ability to read and create shared inscriptions (Goodwin, 1994; Grasseni, 2010).

However, the extent and nature of inscriptional practices varies across different professional fields and settings. For example, Carberry (2003) shows how the work of clinical chemists, who do biochemical tests in medical laboratories, can be understood as the work of 'symbolic analysts'. Most of their work is done by manipulating and interpreting the symbolic outputs of measurement devices and other professional inscriptions. Work of such a thoroughly symbolic kind is also common in other modern-day, hi-tech, hi-skilled professions, such as in finance and

accountancy and in information technology (Knorr Cetina, 2007; Nerland, 2008). In contrast, inscriptional work has a more uneven place in other professions. For example, nurses inscribe only small fragments of their work, though daily handover sheets and other similar symbolic records can play an important role in their practices (Billett, 2014; Eraut, 2009). Some professionals engage with a broad range of representational practices. For example, architects, building engineers and information system designers usually work in multi-professional teams (Adler, 2005; Hall et al., 2002; Sarkkinen & Karsten, 2005). Much of their work is done by juxtaposing multiple kinds of symbolic representations and switching between inscriptions and real-world things. Further, they use inscriptions not only for 'core' knowledge work but also for coordinating their work, planning and managing their cooperation.

Learning to engage with inscriptional work involves several dimensions, including the cognitive, social and material. From the cognitive perspective, external representations mediate perception; and problem-solving requires skill to find effective ways of representing encountered problems in a specific situation.

From the social perspective, the relationship between an inscription and a phenomenon is not fully determined by nature, but established through experience and talk (Roth & McGinn, 1998). Further, complex problems often can be represented simultaneously in a variety of forms – such as textual, figurative and mathematical – and from multiple perspectives, such as engineering, aesthetic and psychological. Creative thinking, inquiry and other higher-order epistemic activities require flexibility in representing problems in multiple ways and seeing connections among diverse ways of inscribing (Verschaffel, de Corte, de Jong, & Elen, 2010). Learning to participate in the inscriptional practices of heterogeneous communities involves mastering a social capability to engage with discourses that join together these multiple perspectives and mobilise diverse ways of interpreting and creating inscriptions.

From the material perspective, we should emphasise that inscriptions are not disconnected from the physical world. Rather they are tightly linked with perception and human action in the world. For example, describing discoveries in molecular biology, Jacob (1988) observes:

> . . . everything depended on the representation we formed of an invisible process and on the manner of its translation into visible effects. (Jacob, 1988, cited in Rheinberger, 1997, p. 102)

However, visibility and representations of professional knowledge are often in an uneasy tension with professional action, particularly in skilful embodied work. On the one hand, as Nonaka (2004) argues, knowledge creation – as the central activity of the knowledge-creating company – depends on making one's knowledge visible and available to others. On the other hand, paradoxically, one of the most evident features of well-done professional work is that, as Suchman (1995) notes, *how* it is done remains invisible to others:

> In the case of many forms of service work, we recognize that the better the work is done, the less visible it is to those who benefit from it. (Suchman, 1995, p. 58)

For example, the smoother the clinical handover, the less visible clinicians' work (and the knowledge involved in this complex process) is, to patients and others. What is written in a medical handover record, how it is written and what is discussed during ward rounds rarely become a focus of attention unless things go wrong. In short, production of knowledge inscriptions is an important aspect of safe, efficient and innovative professional work. Yet, inscribing is not always a natural part of work routines, and when it is, it often stays unnoticed in skilful professional work and is taken for granted (or overlooked) in professional learning. This is particularly the case in social professions where inscribing is fused with ongoing work and inscriptions, despite their critical role in this work, are not the main *outcome* of this work.

We now discuss some important properties of inscriptions that underpin how they function in professional work.

10.2 Functional Properties of Knowledge Inscriptions

Science and technology studies (STS) have a long tradition of looking at knowledge practices not only as a distinct kind of mental work but also as material and mundane activity: as 'writing and imaging craftsmanship' (Latour, 1990, p. 3), in which people work using and producing various documents, texts, prints, figures, diagrams, signs and other representations of what has been seen in, and known about, the world. Latour (1990) identified a number of advantages of visual inscriptions in knowledge production, such as their ability to be 'immutable' and preserve things as they are and to be 'mobile' and have a property of being easily multiplied, disseminated and transported. As he observed, cultures, planets and microbes cannot easily be moved, but pictures, maps and other inscriptions of these things can.

However, Latour also argued that it is not only materiality that makes inscriptions in scientific practice important but also other deeper qualities of inscriptions (Table 10.1). He listed a range of materially bounded yet immaterial properties, such as the possibility of reading inscriptions, of combining inscriptions with one another, of translating from one to another and of presenting things in such a way that they can be 'dominated by hand and eye', independent of the actual shape and size of the things represented – whether a building, a city, the entire world, a tiny chromosome or international trade.

Latour (1990) primarily looked at how scientific visualisations and inscriptions allow the creation of shared scientific knowledge. Knorr Cetina (1999, 2001) and others (Ewenstein & Whyte, 2009; Miettinen, 2005; Nersessian, 2008), who are interested in knowledge work in more dynamic environments, such as laboratories, financial markets and architectural teams, 'corrected' Latour, arguing that immutability is not the only feature of material and digital instantiations that makes knowledge work possible. Their incompleteness, openness and lack of stability are also important. For example, Ewenstein and Whyte (2009) point out that visual

Table 10.1 Some properties of inscriptions in scientific work

Functional properties of inscriptions in scientific work
1. Inscriptions are made 'flat' by removing ambiguities from phenomena; thus, 'nothing is hidden', 'no shadows', 'no *double entendre*'
2. Inscriptions are scalable and this scale can be changed without changing internal proportions. They always can be of a size that can be 'dominated hand and eye', no matter whether the original size is small or large
3. Inscriptions can be recombined, as they have optical or metaphorical consistency which enables the human mind to reshuffle connections in many different ways
4. Inscriptions can also be superimposed on one another combining representations of knowledge from different domains, scales and origins (e.g. combining geological and economic information in one map)
5. Inscriptions allow one to represent three-dimensional objects on a two-dimensional surface (keeping proportions consistent with the three-dimensional space) and investigate them using geometry
6. Inscriptions can also be arranged in cascades and show a phenomenon at different levels of detail or represent its different aspects
7. Visual inscriptions can be made a part of a written text, which allows transfer of both the original inscription and any comment made upon it
8. Inscriptions can be reproduced and distributed at little cost – making copies independent from the time and place where they were originally produced
9. Inscriptions are *mobile* and can be moved from one location to another
10. Inscriptions are also *immutable*, as everything is done to preserve things in inscriptions as they are

After Latour (1990)

representations assist knowing and learning in architectural design teams in at least six different ways. Like Latour, they claim that representations are mobile and that they can have many dimensions and layers and embody a range of knowledges. Nevertheless, these representations are also open and incomplete; they can be read by professionals with different areas of expertise, in different ways, and they emerge in joint meaning-making that is often distributed in time and space.

Inscriptions are common in deliberative knowledge work and also in many other aspects of professional practice. As Wenger (1998) notes, the process of giving form to our experience by producing objects is central to everyday practice.[4] He calls this process 'reification' and includes a range of inscriptional practices and processes, such as:

> . . . making, designing, representing, naming encoding, and describing, as well as perceiving, interpreting, using, reusing, decoding and recasting . . . from entries in a journal to historical records, from poems to encyclopaedias, from names to classification systems, from dolmens to space probes, from the Constitution to a signature on a credit card slip, from gourmet recipes to medical procedures, from flashy advertisements to census data, from single concepts to entire theories, from the evening news to national archives, from the lesson plans to the compilation of textbooks, from private address lists to sophisticated

[4] It is probably most straightforward to think of Wenger's (1998) reified objects here in the sense of 'objects' that we introduced in Chap. 8.

> credit reporting databases, from tortuous political speeches to the yellow pages. In all these cases, aspects of human experience and practice are congealed into fixed forms and given the status of object. (Wenger, 1998, p. 59)

Irrespective of their diverse 'surface' shapes, such reifications of experience have shared 'deep' qualities that support knowing, such as succinctness and the power to evoke meanings, and a focussing effect that allows the making of important distinctions. These features provide possibilities for ongoing cumulative knowing and learning. Nevertheless, all inscriptions are 'double edged', and, as Wenger reminds us, there is no inherent correspondence between the symbolic representations and the objects to which they refer. Inscriptions acquire meanings, properties and functions within cultures, within human intentions and within embodied, embrained, situated actions that bring what was fixed back to life.

Further, there are different kinds of inscriptions, and the generativity of different features depends on who is using the inscriptions and what they are used for. For example, Greeno and Hall (1997) point out that inscriptions are used for both (a) constructing understanding and (b) communicating and sharing.[5] They are embedded within an individual's activities as well as within collective work. When inscriptions are used for individual knowledge work – for representing problems, for articulating important properties of the objects and for figuring out possible solutions – then they can be constructed and adapted for the purpose at hand using standard *and* nonstandard ways of representing. Indeed, nonstandard representations may turn out to be better for such individual work than the standard ones. However, when representations are used for communicating and sharing knowledge with a sizeable community, then inscriptions have to follow conventions for interpretation that are shared within this community.

However, supporting the construction of knowledge and supporting its sharing are not necessarily incompatible features of inscriptions, just as individual and collective work are not necessarily incompatible ways of carrying out inscriptional knowledge-generating work. As Roth and McGinn (1998) point out, some inscriptions act as 'boundary inscriptions' that are used simultaneously to coordinate and carry out joint distributed work. Such inscriptions serve as interfaces between different communities, allowing knowledge and other resources 'to flow' between different actors and different 'social worlds'. Well-studied examples of such 'boundary inscriptions' include the creation of shared museum collections (Star & Griesemer, 1989), flight and airport management and operations routines (Suchman & Trigg, 1991) and design work in architectural teams (Ewenstein & Whyte, 2009). Inscriptions support shared knowledge work in such teams in a variety of ways:

- They provide mutual focus for meaning-making in face-to-face work and coordinate interactions, gestures and other exchanges when things are talked about and co-created.

[5] These two roles of inscriptions draw upon and mirror the two similar roles of signs and language that we discussed in Chap. 9.

- They allow asynchronous work on joint ideas, in groups whose activity is distributed in time and space.
- They help to coordinate diverse activities of people, with various roles and areas of expertise, involved in joint work.

These inscriptions are not only representations of knowledge but also co-configured spaces for carrying out collaborative knowledge work (We elaborate on the nature of inscriptional work in such spaces in Chap. 11.)

Now, we turn from the functions of inscriptions to their deeper qualities, and the knowledge and skills that allow professionals to carry out inscriptional work.

10.3 Skill for Seeing, Inscribing and Knowing the World

What makes inscriptional knowledge work possible? How much of what professionals do with knowledge in their various workplaces is similar to what scientists do in labs? How much resemblance is there between ways of seeing and knowing within practice fields? To better understand the links between knowledge work, professions and inscribing it is worth looking at inscriptional practices in both sciences and professions. As Lynch and Woolgar (1990) claim, if one wants to create knowledge, then it is not enough to represent the object – mere surface resemblance has to be disregarded in favour of deep (theoretical, mathematical) reconstructions of a phenomenon's organisation. The latter opens up the object to active manipulation and exploration of its fundamental organising principles. Latour (1990), drawing on Dagognet (1969, 1973), points out:

> . . . no scientific discipline exists without first inventing a visual and written language which allows it to break with its confusing past. (Latour, 1990, p. 36)

He specifically stresses the importance of shared inscriptional systems that allow representation of the structural and functional qualities of phenomena, while abandoning direct visual resemblance and physical relationships with the represented object. As Latour (1990) puts it:

> Chemistry becomes powerful only when a visual vocabulary is invented that replaces the manipulations [of materials] by calculation of formulas. (loc. cit.)

The importance of explicit and implicit shared ways for 'sorting things out' in everyday life and work and the role of common vocabularies and codification systems that 'open up' possibilities for creating shareable knowledge inscriptions are also acknowledged in many domains of professional work and professional learning (Bowker & Star, 1999; Goodwin, 1994, 1997; Lampland & Star, 2009; Star, 1989; Star & Strauss, 1999). As Goodwin (1994) observes, professional practices are organised around particular shared ways of seeing, coding and representing. This 'professional vision' includes the ability to structure problems, cognitive activity and future actions by using ways of seeing that are shaped through ongoing historical practices and creating representations that can be

recognised in a professional culture. Representations and their purposes in the fields studied by Goodwin – archaeology and jury work – were different. However, he noted three common practices that were used by professionals to structure things and events and explain what had been seen: coding, production and highlighting.

Classification and *coding* is central to human cognition and to socially organised professional practice. Schemes and classifications, as professional and bureaucratic knowledge structures, allow people to structure and reorganise the world and events into 'objects of knowledge' – things that have names, can be compared, can be related, etc. – around which cognitive activity and the discourse of the profession can be organised. The *production* of material inscriptions makes such practice possible as social and cognitive activity. As Goodwin (1994) argues, the ability to create external representations, such as maps and slide rules, that articulate specific ways of seeing and displaying relevant knowledge 'is as central to human cognition as processes hidden inside the brain' (p. 628). However, the human perceptual field is complex. Learning to distinguish relevant things that should be coded, inscribed or (otherwise) used in professional activity involves mastering a set of methods and practices for making specific features of a phenomenon salient and distinguishable – i.e. *highlighting*.

In these respects, knowledge and skill for engaging with inscriptional work, in scientific and professional fields, have noticeable similarities: (a) they both draw on mastery of shared vocabularies, classifications and other tools for inscribing domain knowledge and (b) they both involve similar practices of coding, production and highlighting. However, Goodwin's insights into 'professional vision' are different from Latour's (1990) insights into scientific knowledge production in at least two ways: (a) how things get inscribed and (b) how inscriptions are handled. First, Latour observes that representations of scientific phenomena commonly preserve proportions and other equivalences; thus, 'knowledge discovery' can be carried out by moving around inscriptions without looking back at the world. As Latour puts this:

> If scientists were looking at nature, at economies, at stars, at organs, they would not *see* anything. <...> Scientists start seeing something when they stop looking at nature and look exclusively and obsessively at prints and flat inscriptions. (Latour, 1990, p. 39, original emphasis)

Latour and Woolgar (1979) acknowledge that discovered phenomena not only *depend on* material things, instruments and practices in scientific laboratories 'but are *thoroughly constituted by* the material setting of the laboratory' (p. 64, original emphasis). They nevertheless make a relatively firm separation between the work (and skill) of 'technicians', who handle equipment in laboratories, and the work (and skill) of 'doctors' whose scientific knowledge craft involves reading, writing and shuffling inscriptions.

In short, from this perspective, scientific knowledge discovery is primarily located in the symbolic realm of already inscribed phenomena rather than in the material realm of looking at the world and inscribing what is yet to be known. In contrast, as Goodwin's (1994) notion of 'professional vision' implies, knowledge

work in professional settings rarely permits separation of technical and symbolic work. Professional practitioners look simultaneously at the world and at the inscriptions: they look for and see phenomena in the world, highlight and code it.[6]

Latour also emphasises that scientific discovery relies heavily on active exploration of the fundamental principles in inscriptions: 'shuffling' large numbers of documents, making things flat, putting distant things side by side or looking at thousands of records synoptically, etc. In contrast, as Goodwin's notion of professional vision implies, professional knowing primarily involves deep exploration and reading of the world, rather than just what has already been inscribed.

In short, perception and representation of objects in a symbolic form is an important part of the production of professional knowledge. However, connections with the world can only rarely be abandoned, as the action informed by this knowledge takes place in the world. In fact, once the connection between the inscribed knowledge and the world is lost, then this knowledge becomes of little use for the world and for practice. Thus, the skill needed to manipulate symbolic inscriptions, independently from the skill needed to see the inscribed phenomena in the world, is unlikely to be sufficient for creating actionable knowledge.

Before we discuss other qualities of knowledge inscriptions and inscriptional activity in professional work, we need to look more deeply into how inscriptional work manifests itself in professional learning. To do this, we will introduce a case that will also be featured in later chapters. Here, we focus on the inscriptional work involved in learning to do the work of a school counsellor.

10.4 A Case: Becoming a School Counsellor Through Inscribing Students' Behaviour

To get a sense of a range of inscriptional practices involved in professional learning and work, we want to consider the inscriptional work involved in an assignment project given to psychology students who are planning to become school counsellors. The task asks them to complete a behavioural assessment. Counsellors who work in Australian schools sometimes advise on interventions related to behaviour management of children who exhibit behavioural difficulties. This may involve conducting some psychological assessments. The task given to psychology students thus includes selecting a child who attends a regular school and is exhibiting behavioural difficulties, assessing this child and preparing a full assessment report with proposed interventions and other recommendations.

[6] Of course, not all features of inscriptions and inscriptional practices identified by Latour (1990) hold for all research fields, but differences between research fields are not our main focus. Here, we want to emphasise the point that inscriptions and ways of inscribing in professional work are different from the ways in which inscriptional work has been characterised in the canon of science and technology studies of scientific research.

We use the pseudonyms 'Jane' and 'Ron' in this case. Jane is a student training to be a school counsellor. Ron is an 8-year-old child. Jane receives *a referral* for assessment of Ron's behaviour. Jane reads the referral and reviews his previous school reports. Ron's mother and teacher are concerned about his slow academic progress, low self-esteem and behavioural difficulties. *School records* indicate that Ron was assessed about 18 months ago, and results then showed 'a borderline intellectual disability'.

Jane starts her assessment with observation of Ron's behaviour in a lesson. She *notes* down what is going on in the class and what Ron does, including when Ron gets distracted, talks with other students and requires teacher attention. Jane notices Ron's lack of engagement and his uncooperative behaviour. She sets up an interview with Ron's mother and teacher to clarify their concerns. During the meeting, she asks questions and makes *notes* about what they say about Ron's behavioural difficulties, Ron's social environment and his learning. On the same day, she asks Ron's mother to *complete a behavioural checklist* about Ron's behaviour at home and the teacher *to complete a report form* about Ron's behaviour in classroom. After receiving these completed forms, Jane *calculates* some scores and notices that the results of both assessments indicate some similar 'borderline clinical' and 'clinical' issues relating to Ron's attention and other behavioural difficulties.

Jane observes Ron's performance in a lesson again, but now encounters a very different behaviour. She *notes down* that Ron is quiet and absorbed in a task throughout the lesson, but she also notices differences in the tasks when compared with the first observation and notes that the class was on an excursion in the morning. She hypothesises that Ron's behavioural problems may be due to low cognitive functioning and lack of engagement.

Now Jane meets Ron and initially *administers a test* to assess his cognitive abilities. The calculated results are again borderline, so Jane decides to assess Ron's academic achievements and *administers a test* for assessing reading, mathematics, written language and oral language abilities. She encounters difficulties both in administering this instrument – Ron gets every other item incorrect – and later in calculating the scores. However, after recalculating scores several times, she sees that Ron's results are again low. She suspects an intellectual disability and decides to assess Ron's adaptive behaviour and to conduct an additional session with his mother and the teacher, to discuss her findings and develop an individual behaviour plan.

However, time and other constraints do not allow Jane to make these further assessments, and she has to complete her report drawing only on the information that she has collected. Jane observes that some results are indicative of a potential intellectual disability, but at this stage she does not have enough information to establish this and so comes to a decision that Ron's academic, social and behavioural difficulties in class are caused by low motivation, concentration difficulties and poor fine motor skills.

She *writes an academic report* that summarises the evidence she has collected, explains the tests and their results, justifies her decisions and suggests follow-up assessment strategies. Her report follows the structure detailed in the *assessment*

specification and includes all the information requested, including a self-evaluation, the test sheets and other records. Most of her decisions and recommendations are backed up with references from the psychology literature. The final section of the report contains eight recommendations on how to assist Ron with the management of his difficulties. Jane also *prepares a handout* with a list of strategies for his parents, to assist in developing Ron's verbal comprehension ability (which she found problematic), and she adds this practical tool to the report. She also creates a shorter and simpler version of the *report for the school and parents*.

At the end of the process, Jane *writes a self-evaluation* where she reports on the problems she encountered administering one of the tests and reflects on other challenges and her skills, such as challenges providing reinforcement during testing, and her note-taking skills. For the coursework assessment, Jane submits *the full 'academic' case study* with all the reports, self-evaluation and the practical tools she developed, packaged together.

10.4.1 Some Insights This Case Provides into Learning and Professional Inscriptions

One of the main lines around which Jane's knowledge work evolves is *inscribing*. It is involved when Jane is observing the child with behavioural difficulties, identifying unusual behaviours, coding and drafting a report and in many other parts of her work. The flow of the main inscriptions used and produced by Jane within this task is represented in Fig. 10.1. Jane's work nicely mirrors Goodwin's (1994) account of practices of profession vision: seeing phenomena in the world, highlighting and coding.

However, Jane's work does not stop at *producing* inscriptions, but includes further work *manipulating* inscriptions: calculating test scores, getting results, making hypotheses and planning further tests. This work is not very different from the work of scientists described by Latour (1990), as Jane is indeed fully immersed in making sense of her inscribed and coded data. She reflects:

> Scoring [of one of the tests, (WIAT-II)] is very difficult – I realised that I had looked at the wrong table to convert raw scores to standard scores and hence, had to recalculate all of the data. Also, on a personal note, I'm not sure if I like the WIAT-II. I found it very difficult that some subtests did not have a ceiling level dependent on the student's responses. (From Jane's self-evaluation)

That is, Jane's activity *blends* ways of working with inscriptions that have their roots in both *professional work* and *scientific practices*. This blending goes down deeply to the level of fine-grained inscriptional actions.

Three features stand out in Jane's inscriptional work: (a) switching between various inscriptional strategies, (b) conceptual translation between different kinds of inscriptions and (c) a variety of times and places across which inscriptional activities unfold. We elaborate on each feature below.

Main inscriptions in school counsellor's behavioural assessment

1. Referrals from child's mother and school teacher
2. Review of previous school records
3. Notes from the first classroom observation
4. Notes from parent and teacher interviews
5. Completed Child Behaviour Checklist (CBCL for ages 6-18) with calculated scores
6. Completed Teacher Report Form (TRF for ages 6-18) with calculated scores
7. Notes from the second classroom observation
8. Completed Intelligence scale for children (WISC-IV) with calculated scores
9. Completed Individual Achievement Test (WIAT-II) with calculated scores
10. A handout with strategies for development of child's Verbal Comprehension Ability for parents
11. Self-evaluation
12. Academic case study report for course assessment (university teacher)
13. School counsellor's assessment report for school and parents

Fig. 10.1 Main inscriptions used and produced during assessment of a child with behavioural difficulties
Note: Inscriptions 11–13 are produced using the specification of case study project and behavioural report (see Fig. 10.2)

Firstly, during this task, Jane constantly *switches between several inscriptional strategies*: reading inscriptions (e.g. reading referrals, Ron's records), generating inscriptions (e.g. making observation and interview notes, recording test results on forms), manipulating inscriptions (e.g. calculating test scores, summarising observations) and reinscribing (e.g. summarising information from the referral and school records). Further, Jane not only reads and creates inscriptions related to Ron's case but also uses a range of generic inscriptions, provided by others, such as checklists, tests and templates. These inscriptional tools[7] guide, in Goodwin's (1994) terms, coding, highlighting and production, and, once they are fused with the specific insights about Ron, they become a part of other inscriptions created by Jane.

Secondly, she constantly switches between reading and generating inscriptions and makes *conceptual translations between inscriptions with different epistemic qualities*: for communicating and collecting data (e.g. referrals, checklists) and for making decisions (e.g. calculation of test scores). The inscriptions for communication allow Jane to exchange information with other people, including the school counsellor, Ron's parents, the teacher and the child (e.g. referral, reports), as well as

[7] By 'inscriptional tools' we refer to inscriptions that function as tools. A detailed discussion about tools is presented in Chap. 12.

to collect information from them in a format that is ready for further processing and decision-making (e.g. structured interviews, profile sheets, forms, tests). The inscriptions for making decisions allow Jane to make sense of collected data and make judgements (e.g. using documents with calculated test scores, evidence summarised from observations and interviews identifying behavioural issues). These two kinds of inscriptions are not disconnected, but rather are 'translated' from a language and form that can be understood by 'lay' people (but which often hide professional concepts) to a language and form that make explicit the underpinning features of the observed phenomena and allow generation of professional insights. For example, a set of questions formulated in everyday language in the behaviour checklist completed by parents is translated into the construct 'somatic complaints' and into a calculated score. Jane's findings and diagnosis are then again 'translated' back from the professional jargon into recommendations on how to help Ron to develop his weaker abilities and into a set of specific strategies for parents and teachers who assist Ron on a daily basis. An important feature of such 'reinscription of inscriptions' is that it involves switching between different discourse and linguistic codes and also generates new actionable knowledge (e.g. diagnosis is translated to strategies).

Thirdly, many of Jane's inscriptions are generated in interaction with other people (e.g. the child tests, observation notes, interview notes), and various 'inscriptional lines' are d*istributed across places and time* – moving between the prior 'offline' preparation, 'online' actions and subsequent 'offline' work with the collected data and writing. For example, Jane reads the referral; reviews earlier records; formulates her hypothesis; prepares instruments for assessment *before* action; records information *during* observations, interviews and testing in the classroom and other places; and translates data into the findings and recommendations for further actions *after*. Each such inscriptional line involves a series of inscriptional switches and translations.

One of the most remarkable characteristics of Jane's inscriptional work – and of the final report she presents for assessment – is the *blending* of *professional* and *learning* inscriptions and inscribing. While psychological testing is a real professional task and Jane's report is a real professional artefact, inscriptions and inscriptional strategies involved in completing this task in educational contexts are not *exactly* the same as if they were in a professional setting. They could be characterised as *idealised*, *epistemified* and *educationalised*. These three features, which are characteristic not only of Jane's case but to learning inscriptions and inscriptional practices in professional learning settings more generally, are clearly reflected in the design of this task and in Jane's report.

Idealised inscriptions: First, the specification of the assessment task carries many implicit and explicit assumptions about what is considered to be an appropriate professional *School Counsellor's* report. The specification of the assessment task provides firm recommendations on how the report should be written, including the headings of the sections, what kinds of abbreviations can be used and even

templates of sentences for reporting results (Fig. 10.2).[8] The course coordinator explained this as follows:

> I don't want to be too prescriptive [specifying the content of the report] but there are certain things in terms of writing reports on kids which are pretty standard but that's just a format. And those are the sorts of things you *have to have* there.

Teaching and learning to create such professional inscriptions extends beyond an objective of developing professional knowledge and skill (in any narrow sense) to a broader objective of developing professional ethics, etiquette and values:

> For example, if that report is on a file and this little boy goes to another school, this report that you've written goes to another counsellor. So you don't want a bad [poor quality] report to go, so we've all a bit of professional pride that we do what we do well, but there are a few people, like any profession, who are different. But there are fairly accepted ways of doing things, good practice.

Jane's report has the canonical structure of a psychological report, which is only lightly tweaked for her specific case. Indeed, the unit outline explicitly says:

> . . . you MUST use every heading [of the report], unless it is definitely not applicable; then you MUST justify why there is no information relevant to or pertinent to this point under the appropriate heading. (Behaviour Assessment and Interventions course outline, original emphasis)

Some parts of the report that are not 'exactly relevant' are nevertheless included in Jane's report, but left blank. For example, the section 'Professional referrals' explains 'This section is not appropriate'. In this sense, Jane constructs an *idealised* report, and the inscriptional task given to Jane has a broader implicit agenda. The course coordinator explained this instructional strategy of constructing 'idealised' inscriptions in the following way:

> When people who are already doing it in the field do it, they're probably a bit more haphazard so the students probably do it more thoroughly and fully, but my argument – and the students accept this – is that when they do it, they have to do it more perfectly.

Epistemified inscriptions: Second, there is nothing invisible or accidental in Jane's report. All decisions are explained and all tests are described. Her decisions and recommendations for parents and teachers are justified by providing references to research literature and professional sources. Indeed, as Latour (1990) might say, everything is made flat and transparent, and everything is moved to paper and 'packed' with knowledge. The course coordinator explained that such explicitness and saturation with external knowledge would not be so usual in an experienced school counsellor's report, yet this *epistemification* is an important part of the instructional approach:

[8] Overall, a report is a familiar generic inscriptional form that is used widely to present outcomes of completed work in many professions. However, each professional domain has its own kinds of 'professional report'. Learning to read and create such reports, as well as other generic professional inscriptions customised within each profession, is often among the explicit objectives of professional courses.

A case study report: Behaviour assessment

Headings

(a) identification of your **subject** and the **settings/not real names**

(b) description of **presenting problem(s):** (i) as described in the referral, i.e., quote and; (ii) in **objective** terms, including an initial hypothesis may be written during the assessment process;

(c) details of **screening, assessment and diagnostic tests**

BACKGROUND INFORMATION

BEHAVIOUR DURING ASSESSMENT

ASSESSMENT RESULTS

(d) **Justify** your choice of assessment measures and try to describe and establish a direction and purpose to your assessment using an hypothesis testing approach; this can be combined with your assessment data;

(e) **details of professional referrals**, if appropriate, recommended and/or undertaken, with indication of outcomes; state why if none appropriate;

(f) **summary** of assessment findings, i.e. a brief recapitulation, a short paragraph or a summary list (APA format); can combine with conclusions;

(g) **conclusions,** i.e. what do you interpret from these findings, what does all the presented and summarised assessment data mean;

(h) **recommendations** which might include making a referral for extra support, features of a class-based program, etc.

(i) **sign** your report and put your **qualifications**;

PLUS

(j) **provide a detailed, clear justification** for the interventions/recommendations which have been chosen for this child, including the justification for any resources used/recommended; i.e., **the theoretical and practical bases for your recommendations**

(k) **evaluation of the assessment work** and recommendations, i.e. having finished – what would you consider was appropriate/good/went well? What would you do differently or add or subtract? What did you learn at a personal level?

(l) **references in APA 5th edition style**

(m) **appendices –** include protocols, and possibly copies of relevant research articles and/or chapters, etc.

Fig. 10.2 Headings given to students as a form for writing behaviour assessment report (a slightly edited and abbreviated version)

> Well that's different – in a report, if you're a professional, you don't have to justify it. Whereas they have to say to me – I don't want them just to sort of grab everything they've got in the cupboard and do it. I want them to think about why they're doing it.

In this sense, this professional inscriptional task simultaneously carries three instructional agendas of learning (a) professional skills to inscribe, (b) professional values and (c) professional ways of thinking. That is, students not only *learn to inscribe* but also *inscribe to learn*.

Educationalised inscriptions: Third, as the course coordinator explained, some sections of the report are 'obviously for learning' and clarified that she needs to see not only the final product but also students' work process:

> Yeah. And that [a self-evaluation section] obviously is just for the assignment. Because I need to see their *processes* as well as the *product*.

The invisibility of work that goes into the construction of professional knowledge products requires this melding into professional inscriptions of additional *educational* features. However, the question of how professionals inscribe knowledge that underpins processes of their work, rather than professional knowledge products that they create, extends far beyond solely educational concerns – it is an important aspect of professional inscriptional work and, particularly, professional innovation. We turn to this aspect next.

10.5 Skill for Seeing, Inscribing and Knowing Work

Much of the literature on inscriptional practices has focussed on inscriptions representing knowledge of the world (microbes, diseases, etc.) and outcomes of professional work related to this world (diagnoses, treatments, etc.). However, professional practice involves not only knowledge related to the world but also knowledge related to the work (processes, actions, strategies, etc.). Work involves knowledge that underpins transient actions in the world – that is, knowledge that underpins *performance*. Inscribing the world and inscribing performance require mastering different kinds of 'vision'. In fact, much of the literature acknowledges that inscribing work requires mastering three rather different ways of seeing and inscribing performance – creating inscriptions *for*, inscriptions *of* and inscriptions *within* the ongoing work.

To illustrate this, let's consider some examples. A *plan for* creating a new health service is not the same as a *report of* how such a service was established. Planning involves creating inscriptions *for* the work that will become an intrinsic part of this work. Reporting involves providing analytical insights into how things were done. The former is a projective view of imagined actions that will change the world; the latter is an analytical view of the performed actions that have changed the world. In short, inscriptions *for actions* and *of actions* have different temporal and material relationships to the experienced world, and their production constitutes two different modes of perceiving work and the world.

Both – the plan and the report – are also different from *the documentation* (*records*) produced as a part of the ongoing work of establishing such a health service. The latter is an inscription *within action and within an emerging world*. That is, this kind of inscription is simultaneously for and of action. Inscribing knowledge for, within and of accomplished work constitutes three ways of seeing and relating action to the material realities of the existing world.

This temporal perspective gives a handy way to look at the functions of work inscriptions in knowledgeable action and how work gets inscribed. We briefly elaborate on each of the three ways for seeing and inscribing work in the next three subsections (Sects. 10.5.1, 10.5.2, and 10.5.3), and after that we discuss how these professional visions are reflected in professional courses (Sect. 10.6).

10.5.1 Inscriptions for Work

Norman (1991) notes that inscriptions created for action, such as plans and checklists, have several potential strengths, some more obvious than others. For example, planning can be done before the actual task is carried out and can itself be distributed across time and space; work can be distributed among people; useful inscriptions for work can be created by people who are not directly involved in carrying out the work. Most importantly, the inscriptions change the nature of the task that an individual has to do in action, and simultaneously change the nature of the skill needed to perform that action – for example, cooking without a recipe or navigating without a map. Such inscriptional tools for work can also serve two other purposes: (a) the evaluation of environmental states and (b) the execution of the acts. The former inscriptions mediate perception and interpretation of the world or changes within it; the latter inscriptions mediate actions that result in changes in the world. For example, a checklist can be a tool for shaping 'professional vision' and detecting issues, but it might not assist much with the execution of actions to address those issues. A guidance note about how to do a certain job can assist with the execution of actions, though it *may* not support the development of an understanding of when these actions are appropriate.

One of the most common professional inscriptions used in work is the *plan* (Agre & Chapman, 1990; Schank & Abelson, 1977; Suchman, 2007). However, what plans are, how they are used in human sense-making and how they are embedded within actions are still rather open questions.[9] Many human actions are

[9] The main opinions from research on this matter are distributed along a continuum from the view that plans and other symbolic devices can represent human thought and action (Vera & Simon, 1993) to the view that human thought and action are fundamentally situated and meanings emerge directly in action (Suchman, 2007). We do not want to repeat this debate here (see, e.g. the special issue edited by Koschmann, 2003). We believe that, at this point in time, most of those who have been involved in this debate have more or less agreed that, irrespectively of how plans are weaved into the human cognitive 'fabric', they are always both contingent and important.

carried on without having a plan or planning; and overall, real-world situations and problems are too complex and dynamic to be represented fully in an object-like symbolic form. Nevertheless, plans are important cultural and symbolic resources for guiding human meaning-making, inquiry and action:

> What plans are like depends on how they're used. (Agre & Chapman, 1990, p. 17)

Yet, as Sharrock and Button (2003) put it:

> ... a plan is a technique for the organization of action ... plans are not *theoretically* adequate devices for depicting cases of action but can only be *practically* adequate. (Sharrock & Button, 2003, pp. 260–263, original emphasis)

Collective planning as an activity and plans as shared inscriptions often function as 'activity objects' for joint organisational learning and as 'boundary objects' for orchestrating collective work (e.g. Engeström, 1999, 2001; Miettinen & Virkkunen, 2005; Nicolini, Mengis, & Swan, 2012). Planning and creating other inscriptions for work are also often used as instructional approaches for professional learning (Michael, 1973; Mutton, Hagger, & Burn, 2011). However, their functions in supporting learning, beyond the basic acknowledgement that plans mediate it and their roles depend on the environment, are far less clearly understood.

10.5.2 Inscriptions of Work

Capturing and representing how work is done, and the knowledge that is used in this work, play important roles in improving professional practice and designing new tools for this practice (Falconer & Littlejohn, 2009; Goodyear & Steeples, 1998; Suchman, 1995; Szymanski & Whalen, 2011). The professional capabilities needed to represent one's 'know-how' are increasingly viewed as one of the core professional skills needed for sharing 'best practice' and for developing personal professional knowledge.

Cases, portfolios and videos, as Shulman (2002) notes, are among the inscriptional artefacts used for representing practice. However, capturing work in meaningful ways, such that it can be used beyond one's personal learning, tends to be a complex task. For example, Sharpe, Beetham and Ravenscroft (2004) show how knowledge artefacts used in academia to inscribe knowledge usually take the form of books, papers, case studies, guides, principles, databases and other textual abstractions. While these knowledge inscriptions 'travel' well, they tend not to be very suitable for representing practical knowledge. In contrast, practitioners find it easier to represent and share their practices through images, interactive and video media, narratives, dialogues, presentations, performances and other 'active' inscriptions (Goodyear & Steeples, 1999). Further, effective representations of practice have additional important features that traditional knowledge inscriptions do not possess: (a) they convey the context within which they were created and practitioners' real-life experiences; (b) they are contingent and dynamic, allowing

Table 10.2 Some features of representations of practice

Features of productive representations of practice and practitioners' working knowledge
1. Ownership – representations of knowledge, or at least interpretations of knowledge, should be created by practitioners
2. Reflection and review – representations are needed during reflection of practice, and reflection is important
3. Contingency – less complete representations are better, as they offer more 'room' for the practitioner
4. Dynamism – representations are not locked, but preserve an ability to add, change, improve and adapt them continuously
5. Support for peer learning – networks for creating, sharing and testing representations are a part of representation

After Sharpe et al. (2004)

for practitioners to change them; and (c) they provide opportunities to witness 'the *real thing*, *in the real context*, *with the real people*' (Sharpe et al., 2004, p. 18). In other words, such inscriptions of practical knowledge actually allow one to see this knowledge within action, in context and as experienced. As Sharpe et al. (2004) argue:

> . . . representations of practice need to become 'living' artefacts, enhanced by their participation in collaborative activities. (Sharpe et al., 2004, p. 19)

Such representations of professional experiences, including inscriptions that translate theoretical knowledge to practice (Table 10.2), are 'active artefacts' enhanced by 'living practice' where open and dynamic knowledge inscriptions are further mediated by interaction, meaning-making and remaking.

However, as Suchman (1995) argues, *representations* of work are *interpretations* of work that are crafted for particular purposes and represent particular interests. She identifies several features of inscriptions (representing work) that are often forgotten in more technical discussions of work inscriptions. First, representations of work are generated out of ways of knowing through which this work is viewed. Such representations involve certain choices of what gets represented and how and what stays implicit and invisible. Second, there is an intimate relationship between the representation, work and politics of organisations and contexts in which those representations are generated and used. What is represented is not a neutral perception. What is explicit, seen and inscribed represents also what is considered 'as legitimate to be seen, spoken, and thought' (op. cit., p. 61). Representations of work, in this respect, not only have a rational dimension of creating and sharing knowledge but also carry social order and power and have social and political implications (see also Chap. 2).

So, professional learning is a distinct way of knowing, and inscriptions crafted by students represent their way of seeing and interpreting work and learning. Inscriptions of work and inscriptions of learning to work, as we saw in Jane's case, are often two different interpretations and representations of work and have not only social but also cognitive consequences.

10.5.3 Inscriptions within Work

The two views (above) of inscriptions and inscribing for work, and of work, locate the inscriptional work of a practice outside the time and space of this practice.[10] However, practitioners also create inscriptions to support their knowledge work *within* their situated activity (Roth & McGinn, 1998; Suchman, 1988). They include such things as sketches, drawings, accounting files, daily handover sheets, individual and shared notes and other records. Such inscriptions, generated within daily activities, are often the main carriers of knowledge work and learning (Engeström & Middleton, 1996; Ewenstein & Whyte, 2009). For example, even Jane's case, discussed above, illustrates that her work is a flow of inscriptions, where one inscription (e.g. calculated test scores) informs what should be done and inscribed next (e.g. observation). Such inscriptions closely relate to the inscriptions of (classical) knowledge about the world that we discussed earlier. However, they are not necessarily final products of knowledge work. Rather, they are inscriptions of work generated for work within this work. These inscriptions support situated knowing.

Indeed, while the separation of inscriptions of, for and within work is theoretically possible, they often intersect in practice. For example, Suchman (1995) notes that some technologies and representations created *for* and *in* work are also commonly used as representations *of* work for reporting on those activities. Similarly, Eraut (2009) points out that a range of inscriptions created within professional placements – such as audited accounts, daily handover sheets, building designs, reflective diaries and reflective reports – can be used in higher education as inscriptions of work to represent students' development in work placements and their further learning through reflection. Nevertheless, many inscriptions generated within work often stay inside the work and remain invisible from the outside.

Overall, many accounts of how professional work gets inscribed point to embodied, invisible, local and other situated qualities. These contrast with more idealised accounts of learning for knowledge work – seen as creating knowledge inscriptions that have their own existence outside of the minds, bodies and activities that produced them (Bereiter, 2002). This contrast reflects a tension inherent within professional learning – between inscribing practices situated within educational settings and the need to learn, through them, non-situated skills of inscribing and creating inscriptions of work that can be moved easily across workplace settings. What kinds of inscriptions of professional work and inscriptional skills can travel comfortably across situated practices located and generated in specific contexts? Through what kinds of inscriptions and inscriptional practices do students learn to see and inscribe work?

[10] Some of the most rationalistic accounts even locate it outside the minds and hands of those who carry on this practice. That is, inscriptional tools for practitioners, such as plans, are created by 'experts', and professional practices are audited by external accrediting bodies.

Next, we present some common work inscriptions that we found across a range of professional learning situations. This broader sweep complements the more in-depth study of the case of Jane the school counsellor (Sect. 10.4).

10.6 Analysis of Students' Inscriptions of Professional Knowledge and Work

The temporal relationship between inscription and action that we discussed above (Sect. 10.5) provides a useful way of looking at students' learning inscriptions and inscriptional practices. They can be described as *projective* (inscriptions for practice), *productive* (inscriptions within practice) and *illuminative* (inscriptions of practice). While it is impossible to draw precise boundaries, nevertheless different inscriptions serve particular purposes and involve inscriptional practices that have distinctive features (Table 10.3). Furthermore, most of the inscriptions created by students are designed to serve either a generative function or a communicative function in the construction of actionable knowledge (see Sect. 10.2). We call these 'inquiry carriers' and 'discourse carriers', respectively.

While cognitive and social are two interrelated epistemic modalities of inscriptions – and they, of course, have other modalities, including the material (see Malafouris, 2013) – nevertheless putting one modality to the front and another into the background often requires different inscriptional skills. At least, these skills are often learnt by creating different kinds of inscriptions. That is, inscribing to

Table 10.3 Ways of seeing and inscribing work

Inscriptions	Projective	Productive	Illuminative
Purpose	Production, innovation, change	Performative, executive	Scholarly inquiry, reflection
Time of action	Future	Present	From past to future
Nature of knowledge and knowing	Structurally complex phenomena, distributed in space and time	Functionally complex, transient, phenomena	Invisible or complex aspects and relationships between action and phenomena
Learning of	Values, best practice, etc.	Skill, action	Knowledge, understanding
Context for which knowledge is produced	General, imagined	Existing and specific	Existing, but open
What is inscribed	Structures of phenomena	Traces, elements of inquiry	Complete phenomena
Mediate	Future action	Knowing in action	Reflective, analytical perception
Thinking	Projective	Actionable	Interpretative

Table 10.4 Work inscriptions as 'inquiry carriers'

Inscription and description	Examples
Projective inscriptions Products generated prior to work, to plan, imagine, inspire and strategise	*Plans and models of future actions*: new services, lesson plans, guidelines
Productive inscriptions Interim and final knowledge products generated within work	*Traces of productive inquiry and action*: student behaviour tests, measurements, analytical worksheets, assessment interview notes, observations
Illuminative inscriptions Analytical and reflective products based on one's own and others' work experiences	*Reports from analyses of artefacts of professional practice*: analyses of lesson plans and pharmaceutical products *Reports from inquiry into practice*: reports about school practices, comparative analyses of community pharmacies, analyses of aboriginal officer's roles, reports on social and economic implications of a disease *Reflections on one's own learning process, knowledge, skills and practice in a variety of formats*: reflective journals, portfolios, logbooks, action project reports

support (one's own) professional thinking is not the same as inscribing to support professional discourse.

We discuss some common functions of inscriptions and inscribing in professional learning next. We start the discussion with 'inquiry carriers' (Table 10.4) and then move to 'discourse carriers' (Table 10.5).

10.6.1 Inscriptions as Inquiry Carriers

Projective inscriptions are inscriptions of knowledge for future actions. They include specific 'model' artefacts, such as plans for creating new health services and running health promotion programs, course and lessons plans and field trip designs. In learning, projective inscriptional practices are often oriented towards 'best practice' or change, and they serve a visionary function. While projective inscriptions can be specific and quite well elaborated, they are usually less linked to details of the context, and so they often only outline a shape of the problem solution and actions, rather than specifying all the details. One noticeable attribute of projective inscriptional practices in learning is that they tend to convey values of the profession: 'best practice' rather than just realities of the field. The pharmacy students we studied, for example, were involved in producing plans for future community services, not because teachers thought that these tasks are common in current pharmacy practice, but because they wanted to convey a broader vision of the pharmacist in the community, not only as a person who dispenses prescriptions

but as somebody who improves the overall quality of health and well-being within a community. Projective inscriptions often carry notions of the 'purposefulness' and 'mindfulness' of professional practice, and of 'improvement' and 'innovation', rather than reflecting the habitual, often reactive, nature of professional work.

Productive inscriptions are representations produced by students as a result of tasks that imitate professional inquiry and other kinds of knowledge-generating work, examples being assessments of child behaviour by school counsellors (as in Jane's case, above), or assessments of family situations by social workers. Productive inscriptions usually form a part of transient professional action, dependent on moment-to-moment interaction and skill. These inscriptions often serve a performative function and accompany habitual, functionally complex tasks (as with conducting professional assessments). They are often linked to specific contexts of action and inscribe elements of knowledge of larger, more integrated, decisions or longer-term actions.

Illuminative inscriptions usually result from purposeful 'outsider' inquiry into, or 'insider' reflection on, certain aspects of professional practice. In such inquiry, things and tools of practice, as well as professional practice itself, become subjects of students' professional scrutiny and interpretation. Illuminative inscriptions of work include three broad groups:

(a) Products of analytical work investigating artefacts and tools of professional practice, such as reports analysing lesson plans and qualities of pharmaceutical products
(b) Products of students' inquiries into professional practice itself (Examples from practicum experiences collected in our empirical studies include student teachers' reports produced as a result of their inquiry into the attributes and needs of a school community and comparative analyses of community pharmacies, produced by trainee pharmacists.)
(c) Reflections by students on their own learning, knowledge, skills and practice – in a variety of formats, such as reflective journals, portfolios, logbooks and action project reports

Illuminative inscriptions are interpretations of work. They often draw upon specific things and relate to specific experiences, whether of students or others. However, these illuminative inscriptions often have a sense of 'openness'. The knowledge created is less tied to the specific contexts and situations in which it was experienced and generated and does not relate to specific, immediate or future professional actions. Rather, the aim is to convey understanding for such actions. In the context of learning, illuminative inscriptions often take the shape of academic-analytical tasks such as deconstructions and comparisons and interpretative reflections. Such tasks help students see some of the less visible features of professional practice and knowledge, and make sense of complex relationships between the phenomena investigated and personal professional action.

One common property of the inscriptions described above is that they are inscriptions through which knowledge work is accomplished. They have what Schnotz, Baadte, Mülle and Rasch (2010) call an 'inferential power' (p. 21), and,

in this sense, they are 'inquiry carriers'. As with all inscriptions, they can – and often do – mediate communication and collaborative work with others, but this is not their only – or even their main – function. What is special about 'inquiry carriers' is that they can help their producers to – individually or collaboratively – infer meaning and *create* understanding. For example, a pharmacy student, as a pharmacist, could use a medication assessment report to communicate review findings and recommendations with a doctor, and a student teacher as a teacher might use a course plan to share or discuss their ideas with colleagues and collaboratively improve their planned unit. However, these inscriptions are also 'cognitive partners' through which students – as future professionals – carry out and come to understand their knowledge work.

10.6.2 Inscriptions as Discourse Carriers

The main feature of inscriptions as discourse carriers is that they are purposefully produced to mediate interaction with other people and the environment, rather than for individual mental activity. 'Discourse carriers' are distributed along a similar temporal line as 'inquiry carriers' – they can be created before action, during action or after it – serving projective, productive and illuminative purposes (Table 10.5).

Students produce a range of inscriptions in conjunction with their work designing plans and models for future actions (i.e. in conjunction with *projective* inquiry carriers). For example, our empirical studies showed that designs for health promotion programs and other prospective actions were often complemented with the development of specific discursive tools that could be used to deliver them, such as pamphlets and handouts.

Table 10.5 Work inscriptions as 'discourse carriers'

Inscription and description	Examples
Projective inscriptions Inscriptions for mediating discourse: 'boundary artefacts', instruments via which action will be carried out	*Specific inscriptions for action*: handouts, assessment tasks, disease monitoring tools
Productive inscriptions Traces of actions produced by others and for others	*Natural inscriptions of transient actions and knowledge*: students' works and assessments, counselling information on a medical prescription
Illuminative inscriptions Purposeful mediators of professional discourse that bring produced artefacts and completed actions back into professional communication	*Professional knowledge products and inscriptions of work rendered for presentation and communication*: presentations of case study results and professional guidelines to peers *Purposeful inscriptions of transient actions and knowledge*: peers' and tutors' assessment sheets of role-play performance

Various *productive* inscriptions are created by clients and students themselves through action. Examples include counselling notes on a prescription, students' worksheets and tests. Much of the verbal communication and translation between professional and lay ways of knowing tend to be mediated by such productive discourse. This occurs in many social professions, such as teaching and counselling.

A range of special discursive inscriptions is also created to communicate the results of students' work – including knowledge work – to teachers, peers and other audiences. Such *illuminative* discourse inscriptions may serve explanatory purposes and take the form of presentations, packages of teaching materials, excursion kits, guidelines and other (re)inscribed representations of students' work, but specially rendered to communicate and share their knowledge products with others. While many illuminative inscriptions produced by students are outward oriented – i.e. they aim to support interaction with the external world and other people – some illuminative inscriptions have an inward orientation. For example, assessment sheets used to grade preservice teachers' role-play performance, or video records and other specially produced external traces of professional action, often have this reflective inward-oriented purpose. In these cases, inscriptions are often produced by teachers, peers and other 'observers' and function as raw material for further reflection, interpretation and generation of professional understanding.

'Inquiry carriers' and 'discourse carriers' need to be distinguished and should not be substituted with one another. Both are needed, and while they are closely related, each has particular properties and roles, and each draws on a particular kind of 'inscriptional literacy'. Students, for example, could represent their entire design for a health promotion program by creating 'discourse inscriptions' to deliver it (e.g. booklets, promotion materials), but such discourse inscriptions will not represent how such a program works, what makes it good and other fundamental mechanisms and qualities.

That is, as Lynch and Woolgar (1990) claim, mere surface resemblance does not represent a phenomenon's organisation. The opposite statement is also true. A good plan produced by students does not mean that the students will be able to materialise and enact their inscribed ideas. (Discourse carriers are not the actions, but nevertheless, they bring the mind somewhat closer to the actions.) What's important in such work is an ability to align two ways of seeing: (re)presenting and (re)inscribing practice.

10.7 Insights into the Functional (Pedagogical) Properties of Learning Inscriptions

We will now briefly turn to connect inscriptional practices of students in higher education with some fundamental dimensions of professional learning. We start from Shulman's (2005) ideas about 'signature pedagogies' – powerful types of teaching that organise professional education. Shulman argues that there are three

Table 10.6 Main qualities of the signature pedagogies

Aspects of professional work	Performance	Integrity	Thinking
Pedagogical routines	Habits of the hand	Habits of the heart	Habits of the mind
Knowledge for...	Action	Judgement	Reasoning
Underlying structure of pedagogy	Surface structure	Implicit structure	Deep structure
Inscriptional practices	Productive (within action)	Projective (for action)	Illuminative (of action)

fundamental aspects of professional work to which future professionals are instructed in professional education: *performance*, *acting with integrity* and *thinking*. He notes that pedagogies have all three dimensions, but pedagogical routines through which students are instructed differ fundamentally in their focus and how they form three kinds of habits: 'habits of the hand' (i.e. structure and concrete acts of the profession), 'habits of the heart' (i.e. professional attitudes, values, dispositions and judgement) and 'habits of the mind' (i.e. professional reasoning). He argues that each of the signature pedagogies has a *surface structure*, *implicit structure* and *deep structure*, through which these three habits are respectively formed.

Acknowledging the unique nature of expertise in various professions and without unnecessarily stretching the parallel, we can extend these three dimensions of the professional habits of action, judgement and reasoning to the inscriptional practices: *productive*, *projective* and *illuminative* (Table 10.6). In other words, different types of inscriptional practices learnt and used for learning at university have different relationships to pedagogy and, subsequently, different relationships to the practices within professional cultures.

10.7.1 Learning Habits Through Inscriptional Work

Tasks that mimic 'real' professional tasks usually evolve around productive inscriptional practices and, as a rule, involve the main aspects of 'professional vision': highlighting, coding and production (Goodwin, 1994). For example, such a task as the production of a professional assessment report inevitably requires the student (a) to identify what is relevant and what is not by employing highlighting strategies, such as structured interviews or tests; (b) to classify and code relevant things in professional language, such as 'reshuffling' what was said by a client; and (c) to inscribe what is seen in a certain way, so as to produce a report that could travel from one setting to another. Such tasks and inscriptional work locate professional learning in close proximity to learning 'habits of the hand' and rely on the 'surface structure' of pedagogy (Shulman, 2005).

The literature provides plenty of evidence about the dangers of any habit in professional work – and particularly the dangers of routine unreflected behaviours that could take the shape of the 'habit of the hand' even when people engage in inscriptional kinds of work (e.g. Wenger, 1998). However, some inscriptional habits, as Goodwin (1994) argued, are among 'the distinctive forms of professional literacy' (p. 612). Further, our studies show that productive inscriptional tasks account for a relatively small part of the inscriptional work done by students, even in courses that aim to prepare them for professional fieldwork.

In professional learning, productive and even projective tasks encountered in workplaces (e.g. planning a lesson and teaching it) are often substituted by the illuminative tasks (e.g. analysing plans, teaching resources and video recordings of lessons). What does this kind of substitution mean for learning inscriptional skills for professional work? Can similar professional vision and inscriptional habits be learnt by engaging with the analytical illuminative tasks? We have doubts.

There are some important similarities and deep differences in both cognitive and social aspects of inscriptional practices. We discuss these next.

From the cognitive *inquiry carrier* perspective, the (analytical and explanatory) illuminative work draws on an external observer's 'scientific vision'. While this is different from the productive inscriptional work that draws on canonical 'professional vision', nevertheless the structures of the two visions have some similarities. For example, when the students completed an analytical task asking them to compare several community pharmacies, they (a) identified essential features in pharmacy layouts by *highlighting*, (b) classified them against the official standards regulating pharmacy design by *coding*, and (c) produced a report. The illuminative work and productive work, in this respect, share an overarching commonality – they both require mastering routine skills of professional seeing, coding and inscribing. Similarly, there is no apparent tension at the level of declarative ('know-that') knowledge. The necessary declarative knowledge could be learnt by doing things and/or by analysing how somebody else does or did this. For example, the counsellor could learn declarative knowledge involved in completing the child's behavioural assessments by producing assessments and writing reports or by analysing reports and other inscriptional traces of behavioural assessments completed by other people.

Illuminative and productive inscriptions and their functions in professional work are very different from those that we typically see in scientific work. Professionals most often engage with productive inscriptional work – where they create knowledge inscriptions to solve specific professional problems; they less often engage with illuminative inscriptional work – where they create inscriptions of knowledge that are unrelated to their immediate action.

These two kinds of inscribing draw on different sets of 'know-how' and result in different kinds of habits. For example, (a) picking up relevant things (i.e. highlighting and coding) from the real world and from the reports is not the same thing; (b) inscriptional skills for producing a behavioural assessment report are not the same as for producing an evaluation report analysing behavioural assessments produced by others. These differences become even sharper from the

discourse perspective: ways of knowing and inscribing that are carried over via interacting with people (e.g. children, patients) cannot be learnt by analysing inscriptions, but only by interacting, inscribing and knowing in action.

The importance of illuminative inscriptional practices in learning and professional work should not be underestimated. One could even argue that it is necessary, or at least beneficial, to engage with illuminative inscriptional tasks for learning 'professional vision'. For example, perhaps there is no other good way to learn about the properties of medications, than to analyse available information and complete a report. However, different inscriptional practices assist in learning different kinds of knowing and knowledge – one can't learn habits of the hand by training only the mind.

10.7.2 Linking Professional Inscriptional Work and Innovation

Traditional notions of 'knowledge work' have a rather different character than the knowledge work carried out by professional practitioners as a part of their daily practices and actions – it involves major illuminative inscriptional work, rather than productive inscriptional work. Furthermore, one can see a fundamental difference between professional illuminative work and traditional scientific analytical work. For example, when student teachers learn about the role of an aboriginal officer in a school by completing an inquiry about that role, they do not produce an inscription about 'the role' in general, but an inscription that is about the role of the specific officer in the specific school. That is, professional knowledge that is learnt through analytical inscriptional work involves *forming bridges* between the abstract principles (e.g. the role of such officers, in general) and the situation (a specific officer in a specific school). The nature of such professional analytical inquiry and inscriptions is different from scientific analytical inquiry and inscriptions which normally aim to *break links* between the specific and the abstract, to form abstractions of knowledge that can travel easily beyond the local situation.

One noticeable feature of the illuminative inscriptional practices in professional education is that they are rarely found in just this form in day-to-day professional practice. Professional work does, of course, involve learning and sense-making, but this is rarely accompanied by the creating of inscriptions; it is often done in passing, without much conscious attention. Similarly, professionals do, from time to time, create reflective scholarly inscriptions, but these are usually for sharing their 'know-how' with others, rather than for their own learning (e.g. creating lesson plans and other teaching resources, or guidelines underpinned by best practice, for sharing with other colleagues).

In saying this, we do not want to imply that scientific and professional ways of thinking and ways of doing, or their material and inscriptional practices, are

completely different and incompatible. We accept that the contrasts made between rationality and the formal nature of scientific practices vs. the sometimes arbitrary situated nature of actions in professional settings are more artificial than real (both of them are mundane and material) (cf. Latour, 1990); yet the inscriptional practices and products of these two ways of knowing are not the same. The difference between generic inscriptions that are designed for reuse across situations and concrete inscriptions that are designed for immediate specific action is rather easily identifiable. In fact, the question of knowledge use and reuse becomes central for understanding the nature of knowledge work and inscriptional practices involved in producing professional innovations.

Are practices that underpin traditional professional vision sufficient for innovative knowledge work? It seems that one aspect which is 'invisible' in professional vision is how what is known from individual cases and experiences, and is inscribed in a variety of media, suddenly becomes new shared professional knowledge. Latour would say that this is the job of the bureaucrats who shuffle hundreds of inscriptions around; but then, can professionals themselves create new knowledge?

Professional expertise (and habits) also have a similar form of 'knowing' that is achieved by shuffling via experiences. The main difference is that 'normative' scientific knowing is mainly based on *explicit shuffling* across instances distributed *in space* (across places and cases), while professional expertise often involves *implicit shuffling* across instances distributed *in time* (i.e. along the lines of one's experience). These two kinds of illuminative work are particularly visible in the analytical and explanatory vs. reflective inscriptional tasks.

However, in the context of higher education pedagogical practices for students, learning is not restricted to activities that have a routine repetitive character or those that separate habits of hand from habits of mind and other professional qualities. For example, in our studies we have seen that pharmacy teachers chose the medication review task as a tool to learn 'professional vision', not because of its routine character or pervasiveness in pharmacy practice, but because of the complexity, contingency and pervasiveness of the underlying form of thinking and the complexity of the associated discourse, as well as the explicit articulated character of the underpinning thinking (and inscriptions). Medication reviews, according to pharmacy teachers, help students to learn the underlying structure of thinking that organises many decisions in pharmacy practice. Teachers' understanding of deep features of such inscriptional practices is important. Overall, finding a task that requires the creation of an inscription is important from a pedagogical point of view. That is why the medication review becomes important in learning pharmacy practice. (We elaborate on this case in Chaps. 14 and 15.)

10.7.3 Inscriptions of Knowledge and Professional Actionable Knowledge

There are two distinct aspects to 'professional knowledgeable action'. The first of these is the knowledge and action that are required to make sense of the world (i.e. perception or vision). The second is the knowledge and action that are required to change the world (i.e. decisions about the action and its execution). The former is a part of 'professional vision', while the latter is a part of 'professional action'. They are closely related, but not the same, and inscriptions for perception and for action are different: the former have an illuminative character and require an outsider's view, the latter have a projective character and require an insider's view. Vision and action often come together in inscriptional work around productive inscriptions.

In analytical–interpretative work, an inquiry ends with findings. In contrast, the main products of professional inquiry are not the findings but *decisions and recommendations*. In this sense, analytical tasks and inscriptions may help to learn professional vision, but are less likely to assist in making a decision, producing a recommendation or taking an action.

As Norman (1991) has noted, inscriptions for work change the nature of the task being done by the person or group and the nature and level of skill needed to perform the task. For example, teaching a new lesson with a plan requires different expertise from teaching a new lesson without a plan. While one may argue that this means that novice professionals should be equipped with good 'cognitive artefacts' (manifest in inscriptions) that help them to perform their tasks skilfully, even though they have not yet fully developed their expertise, we want to make a different claim – professionals should be fluent in creating and adapting such inscriptions for the situation and for their work.

As we pointed out earlier, a significant part of students' work in professional courses involves creating different kinds of inscriptions – in which they inscribe knowledge related to actions rather than knowledge representing perceptions of the world. In such cases, professional action becomes an object of inscription itself and part of the practice through which such 'work representations' are created.

This includes projective inscriptions for future work: future nurses create guidelines, preservice teachers create lesson plans and pharmacy students create strategies for community health programs. This activity also includes traces and reflective interpretations of how the work was done: future teachers write reflective journals, social workers create field logbooks, etc.

What does it mean to create such inscriptions for and of work? What kinds of inscriptional practices and knowledge work does this involve? The nature and role of projective inscriptions and inscriptional practices are not well understood in education for the professions.

This diversity of inscriptional practices that characterise professional work and learning should not be forgotten. It is this coordination of heterogeneous practices and inscriptions that makes productive inquiry possible and fluent. It is not the

nature of inscriptions per se but the *consistency between* situational demands and the functions of inscriptions that determines their value in professional practice and learning.

10.8 From Inscribing to (Re)presenting: Personal, System and Enactive Views of Inscriptions

The temporal perspective discussed above gives us one way of seeing functional properties of inscriptions that represent work. It specifically shows *when* knowledge-generating inscriptional work enters a person's activity (i.e. before, within or after execution of action with the inscription) and allows us to see *how the* inscription joins up with a person's action (i.e. by projecting, producing or illuminating actionable knowledge). However, functional properties of inscriptions depend not only on *when* they enter *and how* they relate to a person's actions but also how they enter the person's *way of seeing* inscriptions and inscriptional work within these actions. In short, how are inscriptions seen – *(re)presented* – by the inscribers or those who use these inscriptions in their work?

As a starting point, we can draw on Norman's (1991) distinction between 'the personal view' and 'the system view' of inscriptions.[11]

From the view of a person, who uses an inscription to perform a certain task, the inscription embodies knowledge needed for the task (Fig. 10.3a).[12] As we noted in the last section, the presence of the inscription changes the nature of the task and, simultaneously, changes the personal actor's knowledge and skill needed to perform the task. That is, the inscription permits the achievement of a similar objective as before, but in a different way – and using different personal knowledges and skills – than would occur without the inscription. For example, external memory aids like handover sheets, checklists, to do lists and other inscriptions produced for and used within action, when looked at from the personal viewpoint, change the skills and knowledge needed to perform this action. The actor no longer needs to remember all the information, but instead needs to know how to use these memory aids when performing the job. Such inscriptions could be ready for use (e.g. a lesson plan prepared by somebody else) or could involve some further inscriptional work and thus require a skill to 'complete' the inscription (e.g. a nurse needs the skill to fill in handover sheets). However, the structure of knowledge is embodied in the inscription and is generally stable or, at least, unproblematic (i.e. a nurse does not need to rediscover what to write in the handover sheet and how to write it). Such

[11] Norman (1991) uses the term 'cognitive artefacts' to mean things that have similar representational features and functions as inscriptions: 'an artificial device designed to maintain, display, or operate upon information in order to serve a representational function' (p. 17).

[12] It would be more precise to call this view 'the actors' view' than 'the personal view' as similar inscriptions for work could be also used for collective work.

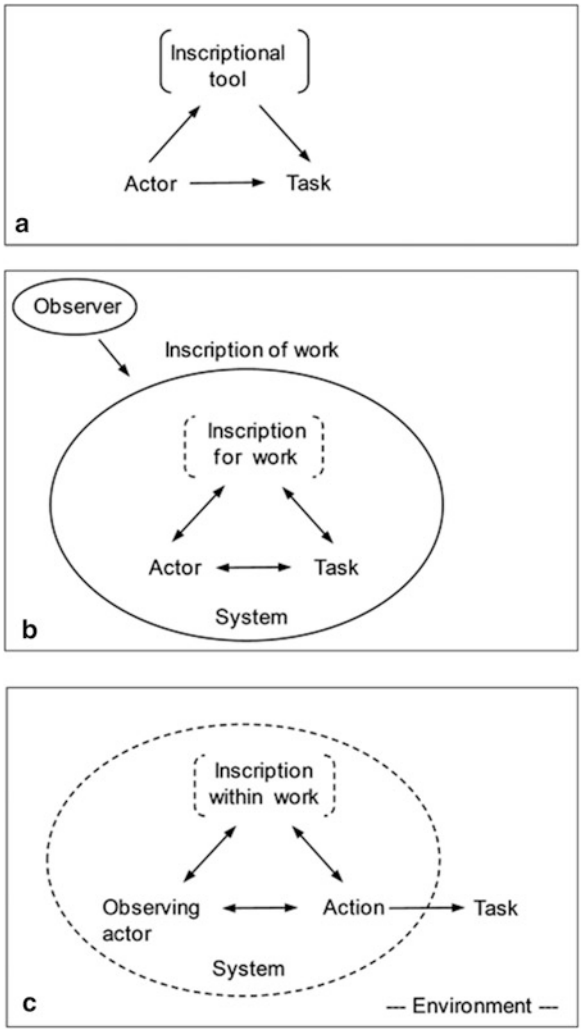

Fig. 10.3 The personal (**a**), system (**b**) and enactive (**c**) views of (re)presenting and inscribing work
Notations: *Brackets* indicate that inscription creates an illusion of stability and independence of the inscribed knowledge from an actor and observer; *dashed lines* show temporality and the relational nature of the boundaries created

inscriptions created and viewed from the personal perspective may *expand* the person's capacities for action, but they do not present or make explicit knowledge embodied in this capacity. That is, the handover sheet embodies, but does not present, knowledge of how to complete and use the handover sheet for a task.

Once seen from *outside*, the knowledge needed to perform the task by the system is distributed between the actor, the inscriptional tool used by this actor and the task (Fig. 10.3b). Thus, once viewed from the system perspective, the inscription of knowledge for action is inscription *of work* and is different from an inscriptional tool used *for this work*. This inscription of knowledge presents all the activity system – including the actors, tools, tasks and relationships among them. That is, work inscribed from the system view represents knowledge of how the work is done

by the whole system. This perspective allows a person to see how inscriptions used within the system relate to the person's skill and the task and how change in one element of the system changes other elements within it. Norman argued that the system view is the representation of the system from outside that system. It is not the insider's view from which the actors see their task and inscriptions used to do it. This view splits inscriptional work into two discrete ways of seeing and representing knowledge needed to perform this work: inscriptions *for* work and inscriptions *of* work.

Inscriptional tasks in professional learning are usually framed from one of these two views. When tasks are framed from the personal perspective, students' learning, as a rule, involves various tasks using inscriptional tools and practices available for tackling such tasks. When tasks are framed from the system perspective, students are thereby asked to step outside the practice and create representations of this practice from the outsider's viewpoint. Jane's inscriptional work nicely represents this gestalt switch: from creating a range of inscriptions using available tools during the behavioural assessment, from the personal view (complete tests, etc.), to the self-evaluation at the end of the project – i.e. from the system view. However, the shared challenge is that knowledgeable action and one's ability to create actionable inscriptions require seeing the system from *within* the system and the inscription not as separable from the task, but as a *part of* the task (e.g. how Jane should tweak the test if Ron missed every item).

Norman's perspectives need to be extended by a third – *enactive* – view. From the enactive viewpoint, cognition is 'an embodied engagement in which the world is brought forth by the coherent activity of a cogniser in its environment' (Di Paolo, 2009, p. 12).

Enactive inscriptions, thus, are dynamic (re)presentations of the work that emerge from the person's actions performed as a part of inscriptional work (Fig. 10.3c). From this perspective, the inscription does not necessarily present how the system works from the outsider's view; it also does not present in advance how the work should be carried on from the actor's view. Rather, it is a dynamic inscription of work which acquires meanings and functional properties within this work. In other words, it is not located outside the system or outside the work, but constituted through action within this work. It is *(re)presentation* of work constituted within this work. This view allows students to see their work – creating and tweaking inscriptional practices and inscriptions for work – as a part of the work that enhances *their* capacity to do the work *and* the performance of the *system* in an environment open for new possibilities and meanings.

References

Adler, P. S. (2005). The evolving object of software development. *Organization, 12*(3), 401–435.
Agre, P. E., & Chapman, D. (1990). What are plans for? *Robotics and Autonomous Systems, 6* (1–2), 17–34.

Belfiore, M. E., Defoe, T. A., Folinsbee, S., Hunter, J., & Jackson, N. S. E. (2004). *Reading work: Literacies in the new workplace*. Mahwah, NJ: Lawrence Erlbaum Associates.
Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Lawrence Erlbaum Associates.
Billett, S. (2014). *Mimetic learning at work: Learning in the circumstances of practice*. Heidelberg, Germany: Springer.
Bowker, G. C., & Star, S. L. (1999). *Sorting things out: Classification and its consequences*. Cambridge, MA: MIT Press.
Carberry, H. F. (2003). *Semiotic analysis of clinical chemistry: For knowledge work in the medical sciences.* PhD thesis. Queensland University of Technology, Brisbane, Australia.
Dagognet, F. (1969). *Tableaux et langages de la chimie*. Paris: Le Seuil.
Dagognet, F. (1973). *Ecriture et Iconographie*. Paris: Vrin.
Di Paolo, E. (2009). Extended life. *Topoi, 28*(1), 9–21. doi:10.1007/s11245-008-9042-3.
Donald, M. (1991). *Origins of the modern mind: Three stages in the evolution of culture and cognition*. Cambridge, MA: Harvard University Press.
Donald, M. (2001). *A mind so rare: The evolution of human consciousness*. New York: W.W. Norton.
Engeström, Y. (1999). Expansive visibilization of work: An activity-theoretical perspective. *Computer Supported Cooperative Work (CSCW), 8*(1), 63–93.
Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work, 14*(1), 133–156. doi:10.1080/13639080020028747.
Engeström, Y., & Middleton, D. (Eds.). (1996). *Cognition and communication at work*. Cambridge, NY: Cambridge University Press.
Eraut, M. (2009). Understanding complex performance through learning trajectories and mediating artefacts. In N. Jackson (Ed.), *Learning to be professional through a higher education e-book* (Ch. A7, pp. 1–17). Guildford, UK: Surrey Centre for Excellence in Professional Training and Education (SCEPTrE). Retrieved from https://www.learningtobeprofessional.pbworks.com
Ewenstein, B., & Whyte, J. (2009). Knowledge practices in design: The role of visual representations as 'epistemic objects'. *Organization Studies, 30*(1), 7–30.
Falconer, I., & Littlejohn, A. (2009). Representing models of practice. In L. Lockyer, S. Bennet, S. Agostinho, & B. Harper (Eds.), *Handbook of research on learning design and learning objects* (pp. 20–40). Hershey, PA: Idea Group.
Goodwin, C. (1994). Professional vision. *American Anthropologist, 96*(3), 606–633.
Goodwin, C. (1997). The blackness of black: Color categories as situated practice. In L. B. Resnick, R. Säljö, C. Pontecorvo, & B. Burge (Eds.), *Discourse, tools and reasoning: Essays on situated cognition* (pp. 111–140). Berlin, Germany: Springer.
Goodyear, P., & Steeples, C. (1998). Creating shareable representations of practice. *Association for Learning Technology Journal, 6*(3), 16–23.
Goodyear, P., & Steeples, C. (1999). Asynchronous multimedia conferencing in continuing professional development: Issues in the representation of practice through user-created videoclips. *Distance Education, 20*(1), 31–48.
Grasseni, C. (Ed.). (2010). *Skilled visions: Between apprenticeship and standards*. Oxford, UK: Berghahn Books.
Greeno, J. G., & Hall, R. P. (1997). Practicing representation: Learning with and about representational forms. *Phi Delta Kappan, 78*, 361–367.
Hall, R., Stevens, R., & Torralba, T. (2002). Disrupting representational infrastructure in conversations across disciplines. *Mind, Culture, and Activity, 9*(3), 179–210.
Jacob, F. (1988). *The statue within: An autobiography*. New York: Basic Books.
Knorr Cetina, K. (1999). *Epistemic cultures: How the sciences make knowledge*. Cambridge, MA: Harvard University Press.

Knorr Cetina, K. (2001). Objectual practice. In T. R. Schatzki, K. Knorr Cetina, & E. V. Savigny (Eds.), *The practice turn in contemporary theory* (pp. 175–188). London: Routledge.
Knorr Cetina, K. (2007). Culture in global knowledge societies: Knowledge cultures and epistemic cultures. *Interdisciplinary Science Reviews, 32*, 361–375.
Koschmann, T. (2003). Plans and situated actions: A retro-review. *Journal of the Learning Sciences, 12*(2), 257–258.
Lampland, M., & Star, S. L. (Eds.). (2009). *Standards and their stories: How quantifying, classifying, and formalizing practices shape everyday life*. London: Cornell University Press.
Latour, B. (1990). Drawing things together. In M. Lynch & S. Woolgar (Eds.), *Representation in scientific practice* (pp. 19–68). Cambridge, MA: MIT Press.
Latour, B., & Woolgar, S. (1979). *Laboratory life: The social construction of scientific facts*. Beverly Hills, CA: Sage.
Lynch, M., & Woolgar, S. (Eds.). (1990). *Representation in scientific practice*. Cambridge, MA: MIT Press.
Malafouris, L. (2013). *How things shape the mind: A theory of material engagement*. Cambridge, MA: MIT Press.
Michael, D. N. (1973). *On learning to plan and planning to learn: The social psychology of changing toward future responsive societal learning*. San Francisco: Jossey-Bass.
Miettinen, R. (2005). Object of activity and individual motivation. *Mind, Culture, and Activity, 12* (1), 52–69.
Miettinen, R., & Virkkunen, J. (2005). Epistemic objects, artefacts and organizational change. *Organization, 12*(3), 437–456.
Mutton, T., Hagger, H., & Burn, K. (2011). Learning to plan, planning to learn: The developing expertise of beginning teachers. *Teachers and Teaching, 17*(4), 399–416. doi:10.1080/13540602.2011.580516.
Nerland, M. (2008). Knowledge cultures and the shaping of work-based learning: The case of computer engineering. *Vocations and Learning, 1*(1), 49–69.
Nersessian, N. J. (2008). *Creating scientific concepts*. Cambridge, MA: MIT Press.
Nicolini, D., Mengis, J., & Swan, J. (2012). Understanding the role of objects in cross-disciplinary collaboration. *Organization Science, 23*(3), 612–629.
Nonaka, I. (2004). The knowledge creating company. In H. Takeuchi & I. Nonaka (Eds.), *Hitotsubashi on knowledge creation* (pp. 29–46). Singapore, Singapore: John Wiley & Sons.
Norman, D. A. (1991). Cognitive artifacts. In J. M. Carroll (Ed.), *Designing interaction* (pp. 17–38). Cambridge, MA: Cambridge University Press.
Rheinberger, H. (1997). *Toward a history of epistemic things: Synthesizing proteins in the test tube*. Stanford, CA: Stanford University Press.
Roth, W.-M., & McGinn, M. K. (1998). Inscriptions: Toward a theory of representing as social practice. *Review of Educational Research, 68*(1), 35–59.
Sarkkinen, J., & Karsten, H. (2005). Verbal and visual representations in task redesign: How different viewpoints enter into information systems design discussions. *Information Systems Journal, 15*(3), 181–211.
Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding: An inquiry into human knowledge structures*. Hillsdale, NJ: Lawrence Erlbaum Associates.
Schnotz, W., Baadte, C., Mülle, A., & Rasch, R. (2010). Creative thinking and problem solving with depictive and descriptive representations. In L. Verschaffel, E. Corte, T. d. Jong, & J. Elen (Eds.), *Use of representations in reasoning and problem solving analysis and improvement* (pp. 11–35). London: Routledge.
Schwartz, D. L., Varma, S., & Martin, L. (2008). Dynamic transfer and innovation. In S. Vosniadou (Ed.), *International handbook of research on conceptual change* (pp. 479–508). New York: Routledge.
Sharpe, R., Beetham, H., & Ravenscroft, A. (2004). Active artefacts: Representing our knowledge of learning and teaching. *Educational Developments, 5*(2), 16–21.

Sharrock, W., & Button, G. (2003). Plans and situated action ten years on. *Journal of the Learning Sciences, 12*(2), 259–264.

Shulman, L. S. (2002). Forgive and remember: The challenges and opportunities of learning from experience. In B. Chase, M. Cochran-Smith, L. Darling-Hammond, L. I. W. Fillmore, E. Lee, & L. Shulman (Eds.), *Launching the next generation of new teachers. Symposium proceedings* (pp. 59–66). Santa Cruz, CA: University of California.

Shulman, L. S. (2005). Signature pedagogies in the professions. *Daedalus, 134*(3), 52–59.

Star, S. L. (1989). The structure of ill-structured solutions: Boundary objects and heterogeneous distributed problem solving. In L. Gasser & M. N. Huhns (Eds.), *Distributed artificial intelligence* (Vol. 2, pp. 37–54). Pitman, CA: Morgan Kaufmann.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's museum of vertebrate zoology. *Social Studies of Science, 19*(4), 387–420.

Star, S. L., & Strauss, A. (1999). Layers of silence, arenas of voice: The ecology of visible and invisible work. *Computer Supported Cooperative Work (CSCW), 8*(1), 9–30.

Suchman, L. (1995). Making work visible. *Communications of the ACM, 38*(9), 56–64.

Suchman, L. (2007). *Human-machine reconfigurations: Plans and situated actions* (2nd ed.). Cambridge, MA: Cambridge University Press.

Suchman, L. A. (1988). Representing practice in cognitive science. *Human Studies, 11*(2), 305–325.

Suchman, L. A., & Trigg, R. H. (1991). Understanding practice: Video as a medium for reflection and design. In J. Greenbaum & M. Kyng (Eds.), *Design at work: Cooperative design of computer systems* (pp. 65–89). Hillsdale, NJ: Lawrence Erlbaum Associates.

Szymanski, M. H., & Whalen, J. (Eds.). (2011). *Making work visible: Ethnographically grounded case studies of work practice*. Cambridge, MA: Cambridge University Press.

Vera, A. H., & Simon, H. A. (1993). Situated action: A symbolic interpretation. *Cognitive Science, 17*(1), 7–48.

Verschaffel, L., de Corte, E., de Jong, T., & Elen, J. (Eds.). (2010). *Use of representations in reasoning and problem solving analysis and improvement*. London: Routledge.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge, MA: Cambridge University Press.