HOW DO MEDICAL STUDENTS LEARN TECHNICAL PROFICIENCY ON HOSPITAL PLACEMENTS? THE ROLE OF LEARNING NETWORKS

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DECLARATION

I hereby declare that, except where explicit attribution is made, the work presented in this thesis is entirely my own.

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Dr Alexander Harding

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DEDICATION

For Liz, Tom, Lucy and Sam.

For stories unread and songs unsung.

ABSTRACT

Medical students spend over 85% of their clinical learning time on hospital placements, but there has been comparatively little detailed analytical investigation. This work therefore seeks to further the understanding of clinical learning in hospitals.

The study adopted a focussed ethnographic approach using quasi-participant observation of third-year medical students, on one hospital placement over a period of two years.

Observations revealed repeating types of learning episodes, which are presented as vignettes. These vignettes are analysed using Actor-Network-Theory (ANT), a branch of material semiotics. ANT seeks to account for both the social and material aspects of learning relevant to complex socio-technical environments such as hospitals. Although theoretically attractive, socio-material approaches such as ANT have been difficult to operationalise for empirical use. I have developed a number of bespoke methodological and analytic approaches that are clearly articulated to enable critique and future use.

Analysis suggests that clinical learning can usefully be conceptualised by learning networks that produce varying opportunities for learning.

The networks comprise human and material participants (or actors), interacting in complex but definable ways. The material actors figure prominently, and often inhibit network formation.

Within learning networks, differing actor combinations generate a range of learning processes that produce a corresponding variety of learning opportunities.

The networks are time consuming to initiate, fragile and short-lived. When operational, networks can contribute to learning technical proficiency, but opportunities to learn clinical skills are rare.

The analysis contributes towards the understanding of medical education by identifying new material and human actors. The analytic process also introduces a systematic way of describing how the actors interact to produce learning.

Identification of new actors and relationships has led to opportunities to improve clinical learning at the observations site and generated several opportunities for further research.

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This account describes the contribution of the doctoral course components to the key themes and central argument. This argument proposes that conceptualising clinical learning as taking place through networks of human and material actors makes a significant contribution to understanding how clinical learning occurs and how it can be planned.

PRE-DOCTORAL THINKING

The work undertaken over the past five years has been driven by two intersecting interests. Firstly, an academic interest in understanding curriculum and secondly, a practical interest in using this understanding to improve medical student learning through my job as a curriculum designer of clinical placements.

At the start of doctoral studies, I was interested in better understanding the differences between curriculum as planned and curriculum as enacted (Miller, Edwards and Priestley, 2010). I was interested in articulating these differences in the clinical context through investigating the differing viewpoints of the relevant stakeholders; curriculum planners, clinical teachers and clinical medical students. Through this process, I hoped to contribute to improving alignment between curriculum as planned and curriculum as enacted.

My initial engagement with the taught part of Doctoral studies therefore focussed on examining the relevant literatures concerning my emerging understanding of clinical learning, which I had articulated as a diagram:

Figure 1 Initial understanding of the clinical learning process (taken from early doctoral work)

Clinical work-based learning

| Curriculum designers | → Knowledge transfer → | Teachers | → Knowledge transfer → | Medical students |
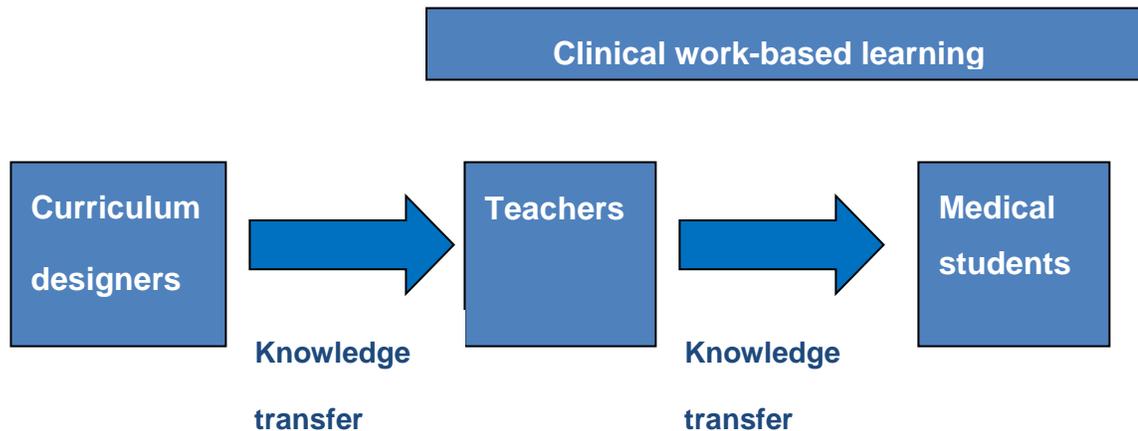
DEVELOPMENT OF THINKING DURING THE TAUGHT MODULES

My approach to the four taught modules involved a sequential analysis of four key fields relevant to my initial understanding of the clinical learning process, as outlined in figure 1:

1. Foundations of professionalism: knowledge transfer
2. Methods of enquiry 1: work-based learning
3. Initial specialist module: curriculum design
4. Methods of enquiry 2: empirical study of medical students, teachers and curriculum designers using focus groups and grounded theory analysis.

1. FOUNDATIONS OF PROFESSIONALISM (FOP)

The first piece of doctoral work examined how professional codes of practice are used by working professionals. I used 'Good medical Practice' (GMP) – the ethical code concerning doctors, to examine how professional knowledge (in this case

ethical practice) is transferred from designers (the GMC), to practising doctors. Examination of the code revealed more than 70 separate guidelines concerning ethical behaviour. Empirical data collection revealed that the code was seldom consciously used, as it did not appear to match the way professionals thought in practice.

It was during this first module that I began to question whether the 'transfer' of curriculum objectives from medical school to clinical teachers might be subject to similar difficulties and that planning clinical work-based placements might be a substantially different process than planning pre-clinical classroom-based learning. In short, I began to see parallels between the problematic transfer of knowledge between GMC and working professionals and the transfer of curricular objectives from medical schools to clinical teachers and hence students.

As this is a professional doctorate, I was particularly interested in being able to articulate the findings concerning how students learn in a way that could be used by curriculum designers.

2. METHODS OF ENQUIRY 1

The purpose of this module was to begin the planning process for a pilot empirical study; the Institution-Focussed Study (IFS). As discussed, my interest at the time was interrogating the differences between the prescribed and enacted curriculum in clinical learning. Preparation of a literature review suggested that notions of clinical learning were heavily influenced by certain elements of the work-based learning literature. In particular the notion of learning through legitimate peripheral participation in communities of practice (Lave and Wenger, 1991).

I became interested in how socio-cultural notions of work-based learning, drawn from empirical data outside medicine may be applied to clinical contexts. Here, the work of Dornan seemed particularly relevant; suggesting that clinical students learned through increasing levels of guided participation in medical work (Dornan *et al*, 2007). However, autobiographical experience and feedback from students at my place of work, suggested that sociocultural interpretations of learning as predominantly a social process did not appear to account for all instances of

student learning and may therefore be worthy of further analysis. Therefore, in tandem with developing an outline proposal for further empirical work, I also began a process of interrogating literatures that might offer a wider-ranging theoretical perspective concerning work-based learning. Initial work identified models that incorporated both social and individual models of learning (Evans, Guile and Harris, 2011; Illeris, 2009a). However, I found these perspectives lacked a clear articulation of how human learners interact with their external environment in work-based learning – especially in techno-material environments such as hospitals. In summary the module began a process of looking for a theoretical perspective that would articulate both the internal / human factors and the influence of the outside physical and social environment in learning. I articulated these emerging thoughts again in diagrammatic form:

Figure 2 Developing understanding of the work-based learning process

Internal / Individual factors ⟷ External / Social and material factors

3. INITIAL SPECIALIST COURSE

This module focussed on interrogating a literature in some depth and I focussed on the curriculum design literature.

Notions of clinical curriculum planning appeared highly influenced by work carried out in classroom contexts and two broad themes emerged; Firstly, traditional notions of curriculum planning, based on the work of Tyler (Tyler, 1949) that were

used at the medical school, that envisaged curriculum as a process of planning, implementation and modification in light of student feedback via evaluation and assessment mechanisms. I termed these curriculum approaches broadly as 'modernist'. Although this modernist model was operationalised at the medical school through the various curriculum committees, my personal experiences suggested that the curriculum influenced learning only to a minor extent.

A second theme to emerge from reading was post-modern notions of curriculum incorporating themes such as gender, ethnicity and power. However, I found that these interpretations of learning were difficult to envisage as pragmatic planning tools.

I was therefore interested to seek a method of articulating learning that negotiated both these modernist and post-modernist concerns. My objectives became to seek a theoretical perspective that could offer rich, integrated interpretations of the learning process, but could also be adapted for use in programme planning.

A practical consequence of these considerations was that I increasingly moved away from diagrammatic representations of learning as I found that these lacked the ability to fully articulate the increasingly varied and disparate factors and relationships involved in work-based learning encountered.

4. METHODS OF ENQUIRY 2

This was pilot empirical work prior to beginning work on the thesis, with the aim of investigating the role of curriculum in work-based learning. I conducted focus groups of learners, teachers and curriculum designers using grounded theory to analyse the data.

The results revealed a number of issues: Firstly, the focus groups suggested that the role of curriculum in clinical learning was far less visible than anticipated. In addition, students appeared to spend large amounts of time not directly engaged in work-related learning. How this contributed to learning was difficult to discern from the data, but the role of material factors appeared important. Moreover, considerable numbers of students appeared dislocated in the learning environment and still others had disassociated from clinical learning altogether. The

mechanisms underlying these processes were difficult to articulate from the findings using grounded theory analysis and it became clear that observational work would be necessary together with an alternative analytic framework capable of articulating the social and material factors evident from focus group results.

INSTITUTION-FOCUSSED STUDY (IFS)

The results of pilot work in MOE2 led to a change in the research focus. As outlined, the influence of curriculum in clinical learning appeared far less than originally anticipated. I therefore became more interested in factors that did appear to influence learning. I reasoned that a better understanding of these factors may contribute to improving educational planning. My central research question therefore became more focussed on how clinical learning was actually occurring. A review of the literature in this field indicated that considerable work had been done on how students learn attitudinal or professional behaviours, but comparatively little work had taken place on how students learned more technical aspects of competence (how to question and examine patients, perform necessary procedures and reach diagnostic and management conclusions). In tandem with this, external examiner comments, conversations with other educationalists and personal experiences with students suggested that there were also emerging concerns among the professional teaching community about the extent to which students were learning technical capability whilst on placements.

The central research question therefore became: How do medical students learn technical proficiency whilst on hospital placements?

This change in focus resulted in considerable further work to refine a new method of data collection (an ethnographic approach using participant observation). This included literature review, negotiating access to the clinical environment and consideration of the ethical implications of observations of teaching and learning carried out by a relatively senior member of the medical school teaching faculty.

In addition, I now adopted a new theoretical perspective (Actor-Network-Theory – ANT) that appeared better able to integrate the multiple factors, perspectives and theories encountered in the literatures relevant to learning in hospitals.

Analysis of results began to provide some of the mechanisms for student learning on placements. However, observations revealed that a considerable amount of student time appeared to be spent learning 'off-timetable' in a self-directed manner that was not captured sufficiently to provide integrated accounts of learning. Further work in refining the observational method in order to account for off-timetable learning was therefore required.

Additional refinements were also necessary to operationalise ANT into a coherent analytic framework. Here, a major impediment was the lack of clearly articulated accounts of how the philosophical underpinnings of ANT – based in post-structuralism, could be translated into an analytic framework capable of empirical use. Several novel analytic categories were necessary in order to provide a set of tools that could adequately describe and analyse the observed clinical learning episodes with the degree of precision required.

THESIS

The thesis represents an attempt to synthesise the issues identified in preceding sections that I now summarised as two research sub-questions concerning how medical students appropriate technical proficiency:

1. How to account for the variety of ways in which clinical students spend their time – including both timetabled learning and off-timetable learning.
2. How does this time contribute to students developing technical competence?

In attempting to better understand this, I sought to provide an analysis of learning that accounted for both the social and material aspects of learning and how these factors are related. Articulating a mechanism to describe relational concepts

between disparate human, social and material factors in a well-developed field proved to be particularly challenging.

The combination of observing actual learning episodes and interpretation using network analysis proved highly productive in identifying opportunities to improve learning and this necessitated forming a group at the observation site to translate research findings into improvements to learning and its planning. Through identification of relevant actors in clinical learning networks, this group had a different membership (students, patient representatives, hospital managers, nurses and junior doctors) to other curriculum groups. Leadership of this group and consequent translation of research findings into curricular improvements represent some of the tangible professional outcomes from this doctoral work.

Perhaps the key theoretical insight gained from the doctoral process has been an appreciation that classroom-based notions and some work-based notions of learning and educational planning do not appear readily translatable to clinical work-based environments and considerable adaptions appear necessary.

Viewing clinical learning as taking pace through networks of human and material actors and using this insight to plan for learning represents the contribution of this piece of work to furthering understanding in these areas. The description of how this is done forms the central work of this thesis.

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CHAPTER 1 – INTRODUCTION

The central argument developed through this study is that clinical learning can be usefully described and analysed by learning networks consisting of both human and material participants (actors).

This argument is developed through five chapters.

In chapter one, I examine the historical basis for an influential interpretation of clinical learning (participation in communities of practice), which is derived from observations of long-term community-based apprenticeships in developing nations. I suggest that for modern medical students, this form of apprenticeship no longer exists and has been replaced by short hospital-based placements. I therefore suggest that new empirical data may contribute to re-evaluating and better understanding how students learn in modern hospitals.

In chapter two, I suggest that socio-material theories such as Actor-Network-Theory (ANT) can provide useful approaches for interpreting learning in complex social and technological environments such as hospitals. However, I suggest that they do not appear to provide the necessary methods or analytic frameworks. I therefore develop a bespoke method and analytic framework to allow interrogation of hospital learning and this is outlined in chapter three.

Description and interpretation of regularly observed clinical learning episodes are illustrated in chapter four using vignettes. The use of networks to interpret these vignettes suggests a range of new human and material actors and outlines mechanisms that trace how these actors interact to produce learning networks. I argue that learning may be produced through these networks.

The findings have considerable implications for how learning in contemporary technical work-based environments is understood, planned and implemented and this is discussed in chapter five.

1.1 HOSPITAL PLACEMENTS

1.1.1 DEVELOPMENT OF HOSPITAL PLACEMENTS

Historical accounts of medical education emphasise the role of apprenticeships, where a student would spend many years learning from an experienced practitioner (Calman, 2006, p. 36). This one-to-one learning arrangement was formalised in 1563 through legislation (The Statute of Artificers).

However, the nineteenth century saw a convergence of factors that resulted in rapid and fundamental change to this arrangement. New technologies such as the stethoscope, microscope and staining techniques facilitated the connection between symptoms and pathological causes of disease, resulting in the development of a clinical method. This involved eliciting symptoms by questioning and examining the patient, testing of specimens and finally, diagnosis and treatment. This diagnostic model of clinical reasoning continues to be the dominant model of clinical reasoning taught to medical students, despite large changes in the nature of care, such as the increasing prominence of chronic diseases.

The introduction of a clinical method, together with technological advances and an increasing population produced a need for larger hospitals staffed by full-time doctors.

The Medical Registration Act of 1858 reflected the increasing influence of hospitals and formally ended the apprenticeship route to medical practice. The Act recommended a hospital-based placement of six to twelve months that replaced apprenticeship. On these placements, groups of medical students were encouraged to attend timetabled ward rounds and clinics undertaken by a team of doctors (or firm). Students were also encouraged to learn 'off-timetable' by searching for patients to practise the new diagnostic process on (often referred to as 'clerking'). In hospitals, nurses and managers acted as gatekeepers to patients and students were frequently unsuccessful in attempts to learn in this manner. One student in 1846 was moved to comment:

'There should be an end to the wandering from bed to bed thro' all the wards' and a 'fixing upon a proper method by which he should enter upon or direct his labours.' (Neville-Bonner, 1995, p. 219)

Little change was made to these arrangements, so that by the time Abraham Flexner, an influential American educationalist, came to Europe in the early 20th Century, he was moved to remark:

'Free run of the hospital for a year furnishes experience, not training.' (Neville-Bonner, 1995, p. 323)

The most recent sustained observations of clinical learning suggest that despite considerable changes to initial (pre-clinical) training as a result of GMC guidance (General Medical Council, 1993), clinical teaching methods have remained largely unchanged:

'The structure of training in most medical schools in England had remained fundamentally unchanged for the last 150 years or so.' (Sinclair, 1997, p. 1)

Clinical apprenticeships for medical students appear to have ended in the mid-nineteenth century and have been replaced by clinical placements. However, the teaching methods have arguably remained unchanged; despite large changes to the nature of medical care. In spite of this, there appears to be a persisting sentiment or ideal of apprenticeship within the profession (Allen *et al*, 2008). Apprenticeship is often used to convey ideals of the dedication required to complete medical training. Clinicians often refer to 'walking the wards', 'mucking in' and learning through 'clerking and seeing the patients' when invoking this sentiment (Medical School internal curriculum documents). To allow for this, considerable time (often described as 'self-directed learning' - SDL) is dedicated on timetables for this activity (see table 1.1).

1.1.2 CURRENT STRUCTURE OF HOSPITAL PLACEMENTS

Today, the majority of medical students undertake a two-part course of five years. The first part is a university-based pre-clinical course covering the scientific foundations of medical practice such as anatomy and physiology. The second part is the clinical course. At present, students spend an average of 85% of this time in hospitals (Harding *et al*, 2015b), undertaking clinical placements of between one and six weeks. Reports of student learning appear focussed around timetabled ward rounds and clinics (Dolmans *et al*, 2001) and this has been well characterised in the literature. However, for much of their time, students engage in a different, self-directed (Murad *et al*, 2010) or self-regulated (Berkhout *et al*, 2015) learning that is more informal. The learning that takes place in this off-timetable location forms a major component of this study as it accounts for a significant proportion of learning time, but appears largely uncharacterised.

1.1.3 THE MODERN HOSPITAL LEARNING ENVIRONMENT

Hospitals provide care to patients and clinical students must learn within this operating environment. This section highlights some contemporary themes in hospital healthcare provision that may influence student learning whilst on placements.

Firstly, it is possible to claim that medical care is increasingly scrutinised and regulated. This may be related to a number of failings in healthcare delivery in hospitals such as Bristol and Staffordshire. Subsequent analysis (Francis, 2013) emphasises the potential role of medical students in highlighting instances of sub-standard care delivered by clinicians. The Francis report (Francis, 2013) also highlights a lack of professional behaviours such as advocacy for patient welfare by clinicians. Subsequently, the GMC has mandated medical schools not to graduate would-be clinicians where there are concerns regarding professional attributes (internal Medical School correspondence).

It is therefore possible to suggest that there is both increasing scrutiny of clinicians by students, and increasing scrutiny of students by clinicians - both of which may

affect learning relationships and make clinicians less likely to let students practise emerging clinical skills on patients. Increases in medical litigation may exacerbate this challenge.

Secondly, the advent of multiple service targets (such as a 4-hour limit on waiting in A&E), increased demand for healthcare (Department of Health., 2013) and reduced funding relative to health inflation (Department of Health., 2013), have changed delivery significantly. Patients have shorter and more intensive admissions, with multiple investigations and interventions. The increasing role of the community means that many patients are now discharged with significant portions of their care subsequently delivered by GPs (Department of Health., 2014). These changes can serve to shorten the available time that students have to locate and learn from patients in hospitals.

Changes to legislation have further altered the delivery of care. The introduction of the European Working Time Directive limits junior doctor working hours and this has resulted in a shift pattern of working for junior and senior doctors. As a result, patients see varying groups of professionals, each working to a different shift pattern. For students, this can result in difficulties in locating doctors to learn from. It may also result in difficulties establishing trust. As discussed, medical staff may be increasingly wary of the risks of students practising on patients.

These developments have taken place since the last ethnographic study of British medical students (Sinclair, 1997) which also pre-dates the widespread use of computers, the internet, mobile technology and advanced imaging.

A brief analysis of hospital placement learning therefore suggests a number of reasons for undertaking this study. Firstly, there have been significant technical, cultural and organisational changes to healthcare delivery since the last sustained observations of medical student learning in hospitals (Sinclair, 1997). Secondly, current notions of how clinical students learn are derived from empirical work concerning apprenticeship learning. Due to the changes outlined, apprenticeship learning may now not fully reflect contemporary hospital placement learning.

1.2 DEFINITIONS

1.2.1 TECHNICAL PROFICIENCY

This study examines the contribution of hospital placements to learning technical proficiency, which I suggest is a significant part of overall clinical competence. I define clinical competence as proficiency in the relevant knowledge, skills and attitudes to fulfil junior doctor duties.

Within clinical competence, I use the term technical proficiency to refer to the necessary knowledge and skills only. Whilst the appropriation of relevant attitudes is important, it has been extensively investigated in observational work (Atkinson, 1997; Sinclair, 1997). Appropriation of technical proficiency has not been the subject of recent observational work and so I am interested to examine more closely how contemporary students learn this, in order that a more complete understanding of clinical competence can be articulated.

In addition, there is evidence that up to 50% of graduates do not feel technically competent to commence practice (Goldacre, Lambert and Svirko, 2014).

At the investigation site, my experiences as a clinical teacher and the comments of internal and external examiners have led me to become more interested in how medical students develop technical proficiency. Several authors have called for research into this area (Dieppe, 2010; Dornan, 2006), as there are concerns that students may not be exposed to enough learning opportunities to develop this attribute.

1.2.2 FORMAL LEARNING, INFORMAL LEARNING AND OFF-TIMETABLE LEARNING

Definitions of formal or informal learning in the clinical learning context were difficult to locate and so this discussion starts with a definition from secondary education:

'*Formal learning is typically institutionally sponsored, classroom-based, and highly structured. Informal learning, a category that includes incidental learning, may*

occur in institutions, but it is not typically classroom-based or highly structured, and
control of learning rests primarily with the learner.'
(Marsick and Watkins, 2001, p. 25)

In the clinical context, I suggest that formal learning is the timetabled activity overseen by the medical school and provided under the auspices of a senior medical school-sponsored clinician. As discussed, these include observing ward rounds, outpatient clinics and operations.

In contrast, I propose that informal learning is the activity organised by the student. This may include activities that in other accounts may be described as 'clerking' patients, shadowing junior doctors and learning from fellow students and nurses (Sinclair, 1997, p. 201).

Some accounts of clinical informal learning, propose that it serves mainly to introduce students to a hidden curriculum (Hafferty, 1998) of work-based culture or the attitudes relevant to work (Baker, Wrubel and Rabow, 2011; Karnieli-Miller *et al*, 2010; Ozolins, Hall and Peterson, 2008; Zhang, Peterson and Ozolins, 2011). Other accounts (Eraut, 2004a) emphasise the role of informal learning in acquiring technical proficiency. In the clinical context, Zhang (Zhang, Peterson and Ozolins, 2011) highlights that 72% of surveyed students considered informal learning to be an important contributory factor in passing exams of clinical knowledge and skills. However, my initial observations (Harding, 2012b) suggested that when students were presumed to be learning informally, their learning was in fact frequently an amalgam of formal and informal methods (as defined above). Students would frequently stop 'clerking' a patient (informal learning) to take part in a ward round (formal learning). In this context therefore, the terms formal and informal appear to lack the necessary precision to accurately portray student learning activity. To avoid confusion, I propose to use the term 'off-timetable' learning to denote the time that students spend not engaged in formally timetabled learning activities. As discussed, this time is often referred to as 'SDL' (self-directed learning) and I have suggested that it accounts for a significant part of clinical learning. In order to emphasise this point, the learning timetable for third-year paediatric students (the

subject of my observations) is presented in table 1.1, where SDL time is highlighted in red.

Table 1.1. Timetable for 3rd year medical students on Bramble paediatric ward (location of study)

	Monday	Tuesday	Wednesday	Thursday	Friday
			0800 Postgrad teaching	0800 Postgrad teaching	
AM	Academic day (lectures at the medical school)	0900-1030 Introduction and bedside teaching (Consultant) **10.30-12.00 SDL**	0900 Ward Round on Bramble or **shadow on-call Paeds SHO (junior doctor) - SDL**	0900 Outpatient Teaching Clinic Area J	0900 Ward Round on Bramble 1130-1300 Clinical competency (Assessment)
12-1		SSL (tutorial)	SSL (tutorial	CPC (tutorial)	
PM	Academic day (lectures at the medical school)	1300 – 1400 Lunchtime meeting **1400 - 2000 Clerk patients in A&E or the ward - SDL**	1300-1500 Teaching in Seminar room at Centre for Women's Health **1500-1700 SDL**	**1400-17.00 Shadow SHO on call - SDL**	1400 - 1600 FEEDBACK SESSION (Assessed student case presentation) **1600-1700 - SDL**

The formal timetable presented often did not accurately portray student activity and appeared to under-estimate the time spent undertaking SDL or off-timetable learning.

For example, on Wednesday morning, other students were often already present on the ward round and the students were advised that it would not be possible to join the round due to excess numbers. This meant that for the majority of

Wednesday the students undertook off-timetable learning. On Thursday, the outpatient clinic took place in small rooms. An informal hospital rule (not articulated on this timetable), stipulated that only one student could be present at the clinic due to lack of space. The three students on the placement therefore took turns for an hour each. This meant that up to two-thirds of Thursday morning was spent undertaking off-timetable learning. On Thursday afternoon, 'shadowing' a junior doctor (SHO), depended on students being able to make contact with them. As discussed, junior doctors changed continuously on the ward due to shift working and so contacting the correct one was frequently problematic and resulted in further 'off-timetable learning for students. Finally, Friday assessment and feedback sessions were frequently shorter than the advertised timetable, again resulting in students spending time undertaking off-timetable learning.

At the observation site, paediatrics had a relatively high proportion of formally timetabled activity (internal curriculum documents). Other rotations on surgical and acute admission wards had fewer timetabled activities and consequently off-timetable learning accounted for a higher proportion of learning time.

The formal timetable for external inspection and finance purposes, suggests that about 40% of learning is off-timetable and the remaining 60% formal and this is broadly similar to other findings in the clinical education literature (Van-Hell, Kuks and Cohen-Schotanus, 2009). However, initial observations of student learning suggested that students spent considerably more of their time undertaking off-timetable learning and this is more congruent with findings outside the clinical education literature (Coffield, 2000).

In summary, off-timetable learning represented a significant proportion of medical student experience at the observation site. Analysis of this time therefore forms a significant part of this study.

1.3 PERSONAL BACKGROUND

I have used observation of medical students as the primary data source in this study. Observation is not a value-free process and perceptions can be influenced by many factors. Some relevant personal factors are therefore outlined.

I am the son of a teacher and physiotherapist and have worked as a doctor and educator in NHS general practice for 25 years. For the past ten years, I have also held a management post at the University of Exeter Medical School, responsible for curriculum design and quality assuring student placements.

As a doctor responsible for deployment of substantial sums of public money, often provided via taxation from people in difficult financial circumstances, I feel a sense of duty to ensure that this money is effectively used. Similarly, in my educational role I am responsible for substantial amounts of public money and its appropriate deployment.

This thesis represents the pedagogic arm of a long-term project adopting a strategic approach to improving the quality and cost-effectiveness of medical education at my institution and in the wider educational community:

1. Ensuring adequate finances to provide teaching locally and nationally (Harding *et al*, 2015a; Harding *et al*, 2015b)
2. Improving the quality monitoring procedures regarding clinical teaching based on empirical work regarding the views of clinicians regarding medical students (Harding and Sweeney, 2013; Harding, 2011)
3. Examining and changing the role of curriculum in clinical teaching (Harding, 2012b)
4. Examining how students learn technical proficiency in a hospital environment and how this may be improved (this thesis)
5. Subsequent delivery of new approaches to student placement learning based on the results of this research (Worley *et al*, 2016).

As well as my social and political beliefs that centre on equality of opportunity and fair distribution of resource, I also hold beliefs about education - influenced by disappointing learning experiences as part of my own medical training. At times, this led me to distance myself from educational experiences afforded to me as a student. Regret for lost opportunities and a resultant desire to improve the experience for future students provides strong motivation for the work I have undertaken over the past ten years.

Accordingly, a significant part of the rationale for this study was to investigate if the research findings could be used to improve student learning. The ethical and methodological implications of this stance are addressed in subsequent sections.

1.4   RATIONALE AND FORMULATION OF THE RESEARCH QUESTION

As an NHS clinician and curriculum designer, I have a professional interest in designing and delivering effective clinical learning within financial constraints. This interest is augmented by past experience of clinical education and a commitment to responsible deployment of state resources.

I have suggested that currently influential theories of clinical learning asserting that learning takes place through sustained participation in the clinical work of teams may need further analysis. This is because these theories derive from observations of long-term apprenticeships in mainly developing nations. I propose that medical student learning in the UK is not apprenticeship-based, but a series of short placements, based in highly technical environments that have changed significantly since the last sustained observations.

On modern clinical placements, I argue that students spend the majority of their time undertaking off-timetable activity that includes both formal and (predominantly) informal learning. This learning appears under-represented in the literature where accounts emphasise the importance of learning professionalism. I am interested therefore, in providing a contemporary account of how medical students learn more technical attributes during timetabled and off-timetable

learning and how this data may be used to improve student learning. This can be articulated as a core research question:

How do medical students learn technical proficiency in a modern hospital?

This core question encompasses a number of more specific considerations:

1. What do students do on clinical placements to learn technical proficiency?
2. How do they go about doing this?
3. How does this contribute to the development of technical proficiency attributes such as:
   a. Clinical knowledge
   b. Clinical reasoning
   c. Clinical skills
4. How can study findings be utilised to improve student learning at the observation site?

In order to interrogate what is currently known in this field, I now turn to a theoretical approach that may illuminate relationships between both the human and material factors relevant to contemporary clinical learning in hospitals.

CHAPTER 2 – LITERATURE REVIEW

In this chapter, I show how I have used an analytic framework that is based on Actor-Network-Theory (ANT) to analyse the clinical learning context.

The analytic framework has been developed through an iterative process - alternating between an interrogation of the ANT literature and interpreting emergent data from observations. I therefore refer to earlier doctoral work and relevent emerging data throughout this chapter to reflect this process.

In the second part of the chapter, I use my analytic framework to critically analyse existing research about medical student learning in hospitals.

2.1   THEORETICAL PERSPECTIVE - ACTOR-NETWORK-THEORY

2.1.1   LITERATURE SEARCHING

I performed database searches using a combination of search terms (ANT, medical student, undergraduate, medicine). Both medical (Medline) and educational (Education Resource Information Centre - ERIC and British Educational Research Association - BERA) databases were used. I identified one empirical study of ANT use in undergraduate medical education (Smordal and Gregory, 2003) and one commentary about its potential use (Bleakley, 2012).

I therefore widened database searches using ANT and broader terms such as socio-material theories, medicine and education. This process yielded search results numbering hundreds and so I applied limits such as dates and full text only. I applied further criteria on reading abstracts such as an emphasis on empirical studies. I was able to identify 42 studies in this way.

In tandem with this, I consulted with ANT practitioners and located recommended texts. I was able to identify three books that were relevant to the study. One summarising the work of ANT in education in general (Fenwick and Edwards,

2010), one summarising ANT in educational research (Fenwick and Edwards, 2012) and one using ANT to interpret medical practice in hospitals (Mol, 2002).

2.1.2 BACKGROUND TO ANT

'A descriptive vocabulary which makes possible the analysis of different patterns of connection.' (Law and Hassard, 1999, p. 7)

Actor-Network-Theory (ANT) is strongly influenced by poststructuralism (Fenwick and Edwards, 2010, p. 1). One of the claims made by poststructuralism is that the meaning of texts and phenomena is derrived as much from the varied and complex relationships between constituent parts, as the parts themselves (Belsey, 2002, pp. 5-6).

ANT developed in Paris, through a number of studies examining the role of social processes in generating technical and scientific knowledge (Callon, 1986; Latour, Woolgar and Salk, 1986; Law, 1986).

ANT proposes that both social and material considerations play equal parts in the analysis of activities such as clinical learning. As such, it is often characterised as a socio-material theory (Fenwick, 2014). ANT may therefore have particular relevance in analysing learning in hospitals that are complex social organisations but also heavily dependant on technological (material) devices.

John Law (Law, 2009) and Tara Fenwick (Fenwick and Edwards, 2010) have done much to translate some of the complex and ambiguous ideas of ANT into English and this account draws extensively on their work.

Broadly, ANT proposes that meaningful activities (such as clinical learning) are brought into being not only through social and material 'actors' (such as students, teachers and computers), but also how these actors are related to produce networks (Fenwick and Edwards, 2010, p. 4). It is this 'Actor-Network' that ANT proposes produces meaningful activity such as clinical learning.

ANT has developed an extensive analytic vocabulary to describe actors, relationships and networks and this study sought to adapt and apply this terminology to clinical learning.

It is important to emphasise that the term 'network' is a translation of the French 'reseau'. Reseau is a word that describes both mind and body in such a way that they are synonymous (Latour, 1996), and a similar word or sentiment marrying two such concepts is difficult to find in English. Actor-Network accounts therefore endeavour to move beyond conventional dualities (as outlined above), to provide integrative accounts.

Nevertheless, an analytical vocabulary is necessary for this task. Therefore, to operationalise the theory for use in this context, I have defined and described the separate network components, but have reassembled them into more integrated accounts in later sections. Where I could not locate ANT terminology that matched emerging data, I adapted closely related concepts – in some cases producing new terminology. I tried to keep this to a minimum but was at the same time aware of 'revisability and diversity' as markers of 'the most interesting work' (Law, 2009, p. 142).

2.1.3 AN ANT-BASED ANALYTICAL FRAMEWORK

Each of the following sections engages systematically with the architecture of ANT: the actors, relationships, networks and the outcomes of networks relevant to developing technical proficiency.

2.1.3.1 ACTORS

'ANT focuses not on what texts and other things mean, as in much qualitative research, but on what they do. What they do is always in connection with other human and non-human things. Some of these associations link together to form an identifiable entity or assemblage, which ANT refers to as an actor that can exert force.' (Fenwick and Edwards, 2010, p. 4)

Here Fenwick appears to suggest that the critical attributes of an actor comprise:

1. Human or non-human (material) qualities; both appearing equally influential (in ANT terminology: 'symmetry')
2. An ability to do things and an ability to mean things (although Fenwick suggests that ANT emphasises examining what things do).

The ability of actors to do things because of their physical characteristics I termed their action function and the ability of actors to exert meaning and influence by non-physical means I termed their semiotic function. Following Fenwick I therefore defined an actor as a human or material entity that may project action or semiotic functions. This discussion introduces a number of analytic terms that form the basis of further discussion:

1. Human actors
2. Material actors
3. Action and semiotic functions of actors
4. Symmetry between human and material actors

1)   HUMAN ACTORS

This study examined how medical students learn technical proficiency and I defined human actors as those human actors that along with medical students may exert influence (through action or semiotic functions) on how medical students acquire technical proficiency.

Some human actors (such as medical students and senior teachers) have been well described in clinical learning and these literatures are analysed in a later section. However, other actors such as nurses, patients and junior doctors appear less-well characterised. Still other actors exerted considerable influence on student learning in early observations, but had not been characterised. These

include hospital managers and other members of clinical delivery teams such as porters, physiotherapists and patient visitors.

2)   MATERIAL ACTORS

Following the work of Fenwick (Fenwick and Edwards, 2010), I have conceptualised material actors in this study as a heterogenous collection of non-human entities exerting influence on student clinical learning.

Several commentators have suggested that the contribution of material actors is under-represented in education literature in general (Fenwick and Edwards, 2011; Fox, 2002) and the clinical learning literature in particular (Lassen, 2012).

The role of material actors has received some attention in more general ANT studies of healthcare delivery (Ackerman *et al*, 2012; Smordal and Gregory, 2003). Both studies chart how material actors (Personal Digital Assistants -PDAs and self-service diagnostic kiosks), can become rapidly redundant in hospital environments. In both studies, the objects were not used; either because they interfered with the rapid turnover of medical work (the service network) or because they did not physically work in the hospital setting. Both authors comment on the somewhat isolated way in which the objects were developed separately from their intended environments.

In Smordal's study relating to undergraduate learning in hospitals, a mismatch between the formal curriculum articulated on PDAs, and the enacted curriculum of the students resulted in the devices becoming redundant. We may state this differently to suggest that relationships failed to form between the human actor (student) and the material actor (PDA) due to the redundancy of the information contained in the PDA.

In contrast, Nespor (Nespor, 2011) highlights how meticulous planning can result in a successful educational intervention involving a material actor. Nespor describes the introduction of an interactive video for college students that resulted in successful network formation. The online format established relationships between

human (student) and material (computer) actors by being convenient (the equipment worked and was easy to use) and relevant to student learning needs. Knorr-Cetina (Knorr-Cetina, 1997) has produced a helpful typology of material actors that is mindful of both action and semiotic functions and this is outlined below, together with relevant examples:

1. Instruments – Everyday objects (a stethoscope or door entry keypad).
2. Objects of knowledge – More specific objects that hold information or knowledge (books and software programs).
3. Commodities – The attribution of a cost or numeric value to something. For example the fees charged by Universities for undergraduate medical study.

Material actors are diverse and their role has not previously been interrogated in a systematic way in medical student learning. I have used this classification system in order to provide a systematic analysis of the role of material actors in clinical learning networks.

3)   ACTION AND SEMIOTIC FUNCTIONS OF ACTORS

I was unable to locate an analytic vocabulary within ANT to articulate the actor properties I observed in sufficient detail. I therefore sought to define these properties by using concepts that were as close as possible to those described in the ANT literature.

ANT is often referred to as material semiotics (Law, 2009). Semiotics makes use of a distinction between the physical properties of a text or object (the signifier) and the meaning projected or inherent in the text or object (the signified), which is a mental concept (De Saussure, 2013, pp. 75-78).

In order to derive a more complete analytic vocabulary that is congruent with ANT, I propose to call the material properties of actors the action function and their projected (or interpreted) meaning, the semiotic function. The semiotic function refers therefore to both the external projections of material actors and the internal interpretation of these projections by human actors. The semiotic function is

therefore both an external projection of physical objects and an internal mental process of human actors.

Consideration of human and material actors together with their action and semiotic functions gave a convenient analytic vocabulary to describe how actors were able to form relationships with other actors relevant to student clinical learning. These characteristics are summarised in table 2.1

Table 2.1 Characteristics of actors with examples

Actor	Action function	Semiotic function
Human (Student)	Student looks for patients	Student dresses and talks in particular mannner to win confidence of service network providers
Non-human (material)	Security coded door (allows or prevents entry to ward)	Lights and sounds from technical medical equipment transmit 'danger / sick patient' signs to approaching student

It is possible to argue that some semiotic functions (such as dressing and talking) could also be action functions. This may be true for an individual student from their own perspective (for example the physical act - or action function, of getting dressed). However, in this study I have ascribed functions on the basis of how humans and materials appear to affect network formation from the perspective of an observer. To follow the example, I am therefore interested in 'dress' as projecting a certain significance (semiotic function).

4)   SYMMETRY

In a controversial analytic move, many ANT scholars apply the principle of 'symmetry' to all actors: human and non-human, giving equal importance to all and accepting no 'a-priori' claims to significance (Latour, 2005, p. 76). ANT suggests through 'assemblage' that initially, all relevant actors in a given environment are considered without ascribing conventional hierarchies to any (Law, 2004, p. 41). In educational research this means teachers, students, curriculum, assessment,

pencils, i-pads and vending machines are all initially assembled together and then their relationships considered. This approach has generated considerable debate. Some social constructionists (Bloor, 1999) claim that this symmetry glosses over the fact that humans are different to materials in that they have agency (the ability to decide on a course of action). In rebuttal, Latour (Latour, 1999) points out firstly that human agency and sociality are integral (but not the sole) subjects of ANT accounts and furthermore, ANT seeks to extend social thinking to new fields such as science. Latour claims that ANT seeks to find a route out of the conventional impasse between scientific explanation and social explanation, but as a result risks critique from both.   Secondly, Latour suggests that our contemprary existence increasingly interlinks social and material worlds. Our social and professional entanglement with mobile phones, texting and the internet has lent credence to this interdependence of human and material considerations.

Other critics (Collins and Yearley, 1992) have suggested that dividing the world into human and non-human actors ignores meaningful practices such as cultural and social phenomena. Following Latour, I suggest that ANT attempts to provide mechanisms for social and cultural practices through an examination of the minutiae of relations between human actors – particularly through use of semiotic (or signifying) functions of human actors. However, ANT proposes to expand the descriptive possibilities available in contemporary phenomena by also paying attention to the relationships between human and non-human actors (often described as socio-material relationships). ANT therefore seeks to offer a comprehensive descriptive and analytic framework without giving precedence to established concepts and hierarchies (such as social, psychological, cultural or material).

I adopted the principle of symmetry between human and non human actors and also between their action and semiotic functions – giving no a-priori privileges to any actor characteristic.

2.1.3.2 ACTOR-RELATIONSHIPS

ANT focusses on analysis of relationships between actors to form networks. It is argued that this focus on how actors are related increases the power of the explanation considerably (Law, 2009). However, ANT has developed in a somewhat serendipetous manner which means that there is not always apparent clear distinction between analytical relational concepts. For clarity I have therefore followed the approach used by Fenwick and Edwards (Fenwick and Edwards, 2010, pp. 1-23) in describing key relational concepts, but have adapted this approach where necessary.

1)   FACILITATING AND INHIBITING RELATIONSHIPS

Action and semiotic functions are properties of actors that may contribute to forming relationships, but do not wholly describe the kinds of relationships that may form between actors. Some accounts of ANT make use of the term 'mediator' as a catch-all term to describe actor relationships in general (Latour, 1996). However, I found this term did not provide the necessary precision to describe the variety of relationships observed.

'ANT can show how things are invited or excluded, how some linkages work and others do not.' (Fenwick and Edwards, 2010, p. 4)

Here, Fenwick seems to be suggesting that relationships may work in both facilitating and inhibiting ways and I adopted this terminology to give added discriminatory power in analysis of relationships.

Facilitating relationships are relationships between actors that appear to facilitate network formation and conversely inhibiting relationships are those that appear to inhibit network formation. Some examples of these relationships are given in table 2.2:

Table 2.2 Facilitating and inhibiting actor relationship properties

Component / Actor	Relationship	Example
Human actors	Facilitating	**Junior doctor** helps student find a patient to learn from
	Inhibiting	**Nurse** tells student patient is too tired to see them
Material actors	Facilitating	**Computer software** enabling students to find patients
	Inhibiting	Student unable to open a **door** to access ward because door access code is unknown.

A recurring motif in ANT work is the emergent character of actors and their properties (Law, 2009). The characterisation of actors as facilitators or inhibitors is therefore an emergent and temporary state and subject to challenge and change. For example, the characterisation of a nurse-student relationship as inhibitory to network formation, does not make claims about nurses in general. It suggests that in a particular circumstance, this characteristic appeared a useful way of describing and analysing events.

2)   AMBIGUOUS RELATIONSHIP

In an influential ANT study of GPs, Singleton (Singleton and Michael, 1993) uses the term 'ambiguous' to describe how GPs simultaneously facilitate the national cervical screening programme by recruiting patients, but also inhibit the programme through 'lapses' in administration and other more subtle behaviours. I therefore follow Singleton's work and use ambiguous relationships to describe relationships between actors that are simultaneously facilitating and inhibiting. For example, initial work (Harding, 2012b) found that nurses often facilitated network formation by finding patients for students, but simultaneously inhibited network formation by stating that the student would be stopped from seeing the

patient by doctors on ward rounds, or other clinical staff. In a similar manner to Singleton, I interpreted these types of co-existing facilitating and inhibiting relationship properties as ambiguous.

3) INTERMEDIARY RELATIONSHIP

In this study I have used the term Intermediary to denote weak relationships formed by actors present in networks but whose potential to exert influence was diminished or absent.

This relational concept is attributed to Latour who uses the example of the Challenger space shuttle to demonstrate that after a tragic explosion, many of the material components (actors) were still present, but were not exerting influence on each other to persue the network objective of space exploration (Latour, 2005, p. 81).

2.1.3.3 NETWORKS

> *'A network is an assemblage of materials brought together and linked…that perform a particular function.' (Fenwick and Edwards, 2010, p. 12)*

Following Fenwick and building on the example above, this study has adopted three essential characteristics that define a network:

1. An 'assemblage' (collection) of 'materials' (actors)
2. The actors are linked through relationships
3. The network performs a particular function.

This definition of network raises a potential issue in defining relevant actors, as taken to its logical extreme, any network may potentially involve a limitless number of actors in limitless types of relationships.

ANT studies therefore deliniate the area of study by 'cutting the network' (Strathern, 1996). This involves a decision to limit the field of study to a finite

number of actors and networks. Different ANT studies may define different actors and cut the network in different ways.

Ponti (Ponti, 2011) provides an approach to cutting the network by suggesting firstly, that actors are those parts of a network without which the network would not be able to perform its function. In my study, the function of the examined network is to further student technical proficiency. Consequently, I define a medical student learning network as being formed by relationships between students and knowledge-source actors. Here, knowledge source actors are human or material actors with the potential to further student technical proficiency (for example teachers, patients and patient notes). Following Ponti, it is difficult to perceive medical students learning technical proficiency without these actor-relationships. Initial observations indicated that knowledge-source actors changed very rapidly within learning networks and it was necessary to develop a separate analytic category (learning processes) to articulate the different student, knowledge-source combinations occuring within networks.

Other actors and other networks can influence the network under investigation and this study has analysed these where relevant. For example initial observations found that many of the knowledge-source actors in clinical learning networks belong partially to another network (the service delivery network). This network consists of the human and material actors involved in a network whose primary purpose is to deliver care to patients.

The distinction between learning and service delivery networks draws on the work of Morris (Morris, 2012a) who theorises clinical learning as an interaction between a medical school network and a service delivery network. Providing empirical data and detailed description of the interaction between medical school network actors and the service network actors was a significant part of this study.

2.1.3.4   NETWORK DEVELOPMENT

Characterisation of clinical learning through use of ANT provides a mechanism allowing actors and their relationships to be described.   However, this does not

convey a sense of how the actors and their relationships change over time. Here, a number of considerations are relevant. Firstly, the stability of the network. That is to say, how resistent the network is to outside influences. Secondly, the rapidity of network change and finally, the overall lifespan of the network. Early ANT work described four aspects of network development and change (Callon, 1986):

1. Problematisation: A network emerges or is identified
2. Interessement: Potential actors are identified (or excluded)
3. Enrollment: Actor roles are defined as a network emerges
4. Mobilisation: The stable network exerts influence.

I could not discern these stages of network formation in the clinical learning context because the observed networks were very short lived and changed rapidly. Instead, a prolonged initiation stage occurred, followed by a brief and rapidly changing functioning network which would then end. This is reflected in the following approach to network description and analysis:

1. Network initiation
2. Network maintenance
3. Network disintegration.

2.1.3.5 LEARNING PROCESSES WITHIN FUNCTIONING NETWORKS

Initial data analysis confirmed the importance of a learner and knowledge source actor as central components of a learning network. However, as observations proceeded it became apparent that there were repeating combinations of different learner and knowledge-source actors within learning networks that required categorisation. For example, a student and patient actor produced a process that gave opportunities to practise communication skills through mimicking the clerking procedures of junior doctors and so I termed this a mirroring learning process. However, this process would often be interrupted by the arrival of a doctor after a few minutes. The network was therefore still maintained, but in a different format and involving a slightly different combination of student and knowledge-source

actor. Repeating combinations of actor-relations within a learning network, I
therefore defined as a learning process.

The distinction between a network and its constituent processes is summarised in
table 2.3:

Table 2.3. Learning network and learning process clarification

Category	Description
Clinical learning network	An assemblage of actors that always includes the student and knowledge-source actor. The effect of the assemblage produces facilitating relationships between student and knowledge-source actors, producing the effect of a learning opportunity related to developing technical proficiency.
Learning process	Describes the different types of student – knowledge-source actor combinations possible within a network.

Learning processes have been previously described in the clinical learning
literature (Dornan *et al*, 2007) and these are outlined in more detail in a
subsequent section.

2.1.3.6 NETWORK OUTCOMES

ANT suggests that meaningful practices such as knowledge and learning are
brought into being through networks (Fenwick and Edwards, 2010, p. 4). ANT
proposes that knowledge (and technical proficiency) may vary according to the
type of actor-relations producing it at the time (Verran, 1999). I suggest that
similarly, technical proficiency is variously brought about through learning
networks, depending on the varying actors and relations. Description and analysis
of these networks therefore becomes highly relevent in suggesting what kinds of
learning opportunities may be afforded to students. This study does not quantify
what learning occurred as a result of each perceived network, as this outcome may
be different for each learner and may be subsequently modified by differing
individual experiences. Rather, the study suggests that the presence of certain

actors and relationships in a network produces certain learning opportunities but precludes others.

2.1.4 SUMMARY

An interrogation of ANT literature from education and health backgrounds in conjunction with emergent data from observations provides a framework with which subsequent observational data may be approached. This consists of a set of assumptions and analytic concepts:

1. Actors are human or material entities that have properties:
   a. Action functions
   b. Semiotic functions.
2. A number of relationship possibilities exist between actors:
   a. Facilitating
   b. Inhibiting
   c. Ambiguous
   d. Intermediary.
3. A learning network comprises a learner actor forming a relationship with a knowledge source actor. In clinical learning, this means a medical student forming a relationship with a knowledge source actor such as a patient, teacher or the patient notes. The effect of this relationship is to produce an opportunity to learn technical proficiency. Networks demonstrate change over time, characterised by:
   a. Network initiation
   b. Network maintenance
   c. Network disintegration.
4. Within networks, there are certain predictable learner-knowledge source combinations and these produce different types of learning processes.
5. Technical proficiency is a product of a network of relations between a student actor and human and material actors in the clinical environment.

2.2 ANT ANALYSIS OF MEDICAL STUDENT LEARNING IN HOSPITALS

The literature on clinical learning is large and diverse, reflecting its complexity. Correspondingly there are many participants, theories and concepts and it is difficult to find conceptual tools to link them together to provide a cohesive view of how learning takes place.

In this second section, I use the analytic framework developed in section one to interrogate the clinical learning literature and where relevant, the more general work-based learning literature. ANT conceives of learning as the outcome of a network of actors and their relationships. I have applied ANT to the existing research literature to:

1. Identify the principal actors and their properties. My analysis focussed on the action and semiotic functions of actors and how these may facilitate or inhibit network formation.

2. Identify learning processes and their constituent actors and relationships.

3. Identify learning networks. My analysis interrogated common notions of how clinical learning networks may operate.

4. Identify claims about learning resulting from networks. My analysis focussed on how elements of technical proficiency (knowledge, reasoning and skills) are portrayed in the literature.

2.2.1 LITERATURE SEARCHING

In order to interrogate the clinical learning literature in hospitals I followed a rapid evidence appraisal approach (Thomas, Newman and Oliver, 2013). This search method aims to provide a rigorous review process, within a manageable timeframe, by following a number of pre-determined steps:

1. Definition of search question
2. Clarification of terms in the research question
3. Resultant exclusions from search strategy
4. Search results
5. Quality criteria for inclusion of studies

6. Data handling.

The review process was co-terminous with analysis of my observational data and generated an iterative process where the literature informed initial data analysis and vice-versa. I have made specific reference where recourse to initial data analysis has informed the literature review process.

I defined the overall search question as 'How do medical students undertake clinical learning in hospitals?'

Clarification of terms meant that alternative words were included in the searches. For example, medical students are sometimes known as undergraduates and clinical learning is sometimes referred to as work-based learning, learning environment, experienced curriculum or lived curriculum.

Clarification also led to some exclusions from the searches. This study is focussed on the work-based learning of medical students in hospitals, concerning the development of technical proficiency. Therefore studies located in simulation centres, learning laboratories and lecture theatres were excluded. I also excluded studies done in primary care and nursing environments.

Finally, I excluded quantitative measures of the learning environment that were primarily derrived from approaches such as questionnaires. This is because although these methods can give numeric data about student ratings of learning environment, they do not approach the subject of how learning is done in these environments.

I searched one medical database and two educational databases (MEDLINE, ERIC and The British Education Index - BEI) simultaneously, using combinations of identified terms.

These searches yielded a total of 509 studies. After reading titles, this was refined to 54 studies and after reading abstracts, this was refined to a total of 44 studies. I included papers that had a well-defined method and a convincing amount of data to achieve saturation. I also included papers with a stated theoretical perspective and an analytic method enabling derivation of themes.

Reference lists from these papers were examined and I identified some further studies through this method such as Dornan's extensive review of the undergraduate clinical learning literature (Dornan, 2006). In addition, I undertook hand-searching of a relevant journal (*Medical Education*), from 2007 to the present date. I used grey literature such as other PhD and Masters work and also took advice from experts in the field. These latter approaches were particularly necessary to identify ethnographic studies which were often in book form and were difficult to identify from database searches. I identified three ethnographic studies in this way (Atkinson, 1997; Becker *et al*, 1961; Sinclair, 1997). I excluded books providing descriptive accounts of medical schools that did not have a clear methodology or theoretical base.

All three works predate the significant changes to medical practice and hospitals that have occurred in the past 20 years. However, many of the processes identified in these studies resonated with my own findings. I give some emphasis therefore to these three works; especially that of Sinclair, whose work is based at an English medical school and is the most contemporary study.

The search strategy was not successful in identifying a significant literature concerning the role of material actors in clinical learning. I therefore interrogated the ANT literature as previously described. Here, I identified studies that addressed the role of material actors in the wider healthcare and education contexts.

References were imported and managed on reference management software (Endnote).

2.2.2 ANT ANALYSIS OF CLINICAL LEARNING LITERATURE

Literature searching produced no empirical accounts of ANT in medical student hospital clinical learning but Bleakley has emphasised its potential contribution (Bleakley, 2012). In addition, I could not locate studies that conceptualise clinical learning in ANT terms.

2.2.2.1 HUMAN ACTORS - FUNCTIONS AND RELATIONSHIP PROPERTIES

1) THE STUDENT ACTOR

In practice, medical students, like other actors display characteristics that are at once a mixture of action and semiotic functions (Law, 2004, p. 83). For the purposes of analysis, this review distinguishes between action and semiotic functions in order to survey the extent to which these student characteristics have been addressed in the literature.

A) STUDENT SEMIOTIC FUNCTIONS

In the clinical learning environment, semiotic functions (non-material, external projections and internal interpretations) have been extensively characterised through literatures examining the role of internal semiotic functions such as learning styles, emotional states, character traits, values and knowledge recall abilities. The characterisation of these semiotic functions in theliterature is expanded in the following acount.

Many studies (Balmer *et al*, 2010; Kuper *et al*, 2010; Walton *et al*, 2010) explore the preferred learning styles of individual students. Most of these studies use Sfard's (Sfard, 1998) distinction between an acquisitional style of learning centred on learning facts for assessments - and a more participative type of learning that accentuates engagement with professional practice. The majority of the works suggest a tendency for clinical students to prefer learning by acquisition. These findings complement other models of clinical learning suggesting that students learn through participation (Dornan *et al*, 2007).

The role of emotional states on learning had been extensively explored. Several studies suggest that chronic negative emotional states can act as an inhibitor to network initiation (Dyrbye *et al*, 2009; McConnell and Eva, 2012; Sinclair, 1997; Tsai *et al*, 2014), and that negative emotional states are particularly associated with learning in the hospital service network (Dyrbye *et al*, 2009). Here, semiotic

interpretations such as feeling redundant (Atkinson, 1997) and humiliated (Del Prato, 2013; Dolmans *et al*, 2008) have been described.

In a related discussion, the effects of motivation on student learning are also addressed in the literature. Liljedhal and Boor (Boor *et al*, 2008; Liljedahl *et al*, 2015) find that clinical students can project semiotic signals such as fatigue together with passivity and disinterest compared to nursing students.

The semiotic projections of students outlined in some of these studies such as feeling out of place and unable to contribute to work, begin to suggest that students may spend time in hospitals where they appear not to project semiotic functions associated with participation in either a clinical learning network or a service delivery network.

Internal semiotic functions such as the development of student values and identity within the clinical service delivery network have been the focus for much research in the field. Whilst intimately bound up with the development of technical proficiency, the development of identity is not the primary purpose of this study and the literature concerning this aspect of learning is considerable and has not been interrogated in full here. Becker (Becker *et al*, 1961) provides perhaps the most exhaustive description of identity development amongst medical students. Becker proposes a step-wise development of medical student identity, that is not unduly influenced by the hospital service delivery network (Becker *et al*, 1961, p. 438). This relative independence from the hospital service network was not replicated in initial observations which suggested that contemporary medical student learning was significantly influenced by the hospital service delivery network.

Other research has focussed on other internal semiotic functions such as character traits of students associated with successful clinical learning. Here traits such as persistence and self-reliance have been associated with high intrinsic motivation and better outcomes from clinical learning (Tanaka *et al*, 2009). Doherty summarises these positive attributes as conscientiousness in a review of this literature, claiming that this trait above others increasingly predicts successful outcomes in clinical learning as measured by student assessments (Doherty and

Nugent, 2011). However, Talbott (Talbott *et al*, 2012) finds that access to patients in the surgical service delivery network is independent of related student traits such as assertiveness.

Finally, it is claimed that the extent of student clinical knowledge can influence their chances of successful participation in clinical learning networks (Dornan *et al*, 2007), and junior clinical students worry about their knowledge base as a result (Small *et al*, 2008). Several authors comment on how students attempt to project clinical competence through 'trying on' different personas through variations in dress and speech, with varying degrees of success (Dornan, 2006). This study has sought to extend the understanding of these semiotic projections of competence and their role in clinical learning.

Initial work (Harding, 2014) did not confirm the role of internal semiotic functions such as knowledge recall or character traits in facilitating relationships between students and learning source actors such as patients or clinicians. This was because groups of student actors (with different knowledge bases, traits, learning styles and emotional states) were present at any one time attempting to initiate learning networks within the rapidly changing service delivery network. Groups of students changed every week and clinical teams were not stable. It was not therefore possible for teachers to adapt teaching to these individual variables. The semiotic functions of learner actors identified in the literature search did not therefore appear to facilitate clinical learning networks.

Instead, initial observations suggested that other semiotic functions such as dress, accent, cultural heritage, verbal agility and social mimicry exerted strong semiotic facilitating influences in accessing knowledge sources such as patients. I was unable to locate a significant scholarship relating to these factors.

I suggest the literature has characterised the internal intellectual and psychological semiotic functions of students at length, but has perhaps not fully explored some other external semiotic functions in such detail. In addition, I suggest that the service delivery network (within which clinical learning networks exist) often exerts considerable action and semiotic influences on student's ability to initiate learning

networks. Students may spend time outside both networks and may exhibit counter-productive semiotic projections such as apathy and dissociation.

B) STUDENT ACTION FUNCTIONS

ANT suggests that learning is brought about through networks and so the actions of students to produce learning networks become highly relevant.

I identified a number of studies confirming the range of formally timetabled student actor activities, such as ward rounds, clinics and operating lists (Dolmans *et al*, 2001).

Studies addressing off-timetable learning included ethnographic accounts (Atkinson, 1997; Becker *et al*, 1961; Sinclair, 1997) and these highlight the importance attached to learning diagnostic reasoning and communication skills through the action function 'clerking' (students talking to and examining patients in a formalised manner). Sinclair observed that this is an activity that students were expected to do unsupervised (Sinclair, 1997, pp. 198-203), whilst on placement with a particular clinical team (or firm). However, Sinclair does not outline in detail how students access patients or whether their attempts at doing so are successful. As I have outlined, 'firms' no longer exist and the absence of a stable team may make it more difficult for students to access patients. Contemporary studies of students learning in hospitals have confirmed that student access to patients remains problematic, but these studies do not outline in detail the mechanisms that underlie these difficulties (Celenza, Li and Teng, 2011; Colquhoun *et al*, 2009).

Research sub-question one focusses on what students do in order to learn technical proficiency and this study therefore interrogates the action functions required of modern medical students in order to access and learn from patients to perform action functions such as clerking.

Other studies have addressed more specific student action functions relevant to learning technical proficiency. Jackson (Jackson, Wall and Bedward, 2012) has studied how students can learn modern handwashing techniques in hospitals and Talbott has examined how students can work through a list of technical tasks by visiting inpatients. (Talbott *et al*, 2012). Both studies, however, highlight that

initiating student learning networks can be hampered by difficulties in students performing the action function of accessing patients. Jackson (Jackson, Wall and Bedward, 2012) suggests that semiotic projections from the service network such as dismissive staff attitudes to students may play a part. Tolsgaard (Tolsgaard, 2013) has suggested that to counter unenthusiastic clinical service network actors, students can use 'official' medical school documents to ensure that service network actors observe and assess adequate amounts of technical skills.

Some studies highlight that students can exert action functions that serve to minimise their presence in clinical learning networks (Becker *et al*, 1961; Sinclair, 1997). Other studies have gone further, suggesting that a cohort of medical students can dissociate more-or-less entirely from learning (White *et al*, 2014). However, this study is located in a pre-clinical learning context. As part of sub-question one, this study seeks to interrogate further the extent of student dissociation from clinical learning networks.

Many existing studies do not appear to present a detailed account of the forms and mechanisms of student action and semiotic functions that may underpin clinical learning. An ANT interpretation of the literature that progressed in tandem with initial observations, suggests that additional action and semiotic functions may be relevant to the student actor learning in hospitals: such as the role of external semiotic projections and student action functions that are necessary to access patients to learn from.

2)   THE CLINICAL TEACHER ACTOR

The majority of the literature concerns senior clinical teachers (consultants). Studies relating to junior doctor teaching were more uncommon and were commonly referred to as studies about near-peer teaching. I was able to locate one study relating to students learning from other students (Tolsgaard, 2013). Sinclair makes reference to students learning from nurses, but only in the context of junior doctors talking to students about the importance of this (Sinclair, 1997, pp. 291-3).

A)   SEMIOTIC FUNCTIONS

Teacher semiotic functions addressed in the literature commonly concern factors such as projected motivation and enthisiasm, which are positively associated with student satisfaction (Irby, 1995; Spencer, 2003).

However several studies highlight how material commodity actors such as lack of time, and lack of remuneration can negatively affect motivation (Hendry *et al*, 2005; Parry *et al*, 2008; Seabrook, 2003). Empirical work on the relationship between commodity actors and teacher motivation argues that as teaching load increases, motivation may diminish, unless adequate financial and educational support is available (Harding and Sweeney, 2013).

Ethnographic studies comment on semiotic functions of senior teachers, such as making students feel humiliated. Sinclair argues that this can adversely affect student motivation and in some cases can lead to students dissociating from, or leaving medical courses (Sinclair, 1997, pp. 233-5). Ethnographic accounts also highlight that semiotic projections such as perceived humiliating behaviour from senior teachers can be difficult to predict and can be triggered by idiosyncratic mechanisms (Sinclair, 1997, p. 299).

B)   TEACHER ACTION FUNCTIONS

In a comprehensive review of clinical teachers, Irby (Irby, 1995) suggests that good teachers are able to exert action functions such as supervising clinical learning. Dornan (Dornan *et al*, 2007) emphasises the importance of supervision in his influential model of clinical learning, proposing that supervised participation is the mechanism by which clinical learning takes place. However, Worley (Worley *et al*, 2004) notes that supervision of students is inversely related to the technical environment in which the students are located. In rural primary care Worley finds supervision levels are maximal, contrasting with very low levels of supervision in tertiary care (highly specialised hospitals).

The mechanisms underlying action functions such as 'supervising' or 'supporting' do not appear fully elaborated in the literature. That is to say it is unclear what exactly supervision entails in hospital learning in terms of what is done by clinical teachers to make supervision happen.

Regarding the action functions of clnical teaching itself, ethnographic studies emphasise the action function of questioning students – most commonly in an unstructured manner concerning the extent of clinical knowledge (Atkinson, 1997; Sinclair, 1997).

I located one bespoke teaching model for the clinical environment known as the 'one-minute preceptor model' that suggested questioning and giving explanations in a more structured manner concerning the diagnostic ability of students (Irby and Wilkerson, 2008). However, this model did not apear to be based on a particular theory of learning.

Several other teaching models are more directly derived from theories of learning (Patel, Sandars and Carr, 2015; Spencer, 2003) and these again involve the action functions of questioning, explanation and demonstration by clinical teachers.

In summary, my ANT analysis of the existing literature on clinical learning suggests that teachers facilitate or inhibit network formation through semiotic functions such as motivation and enthusiasm. Motivation may be influenced by material commodities such as time available, student numbers and remuneration. Teachers exert action functions such as locating patients, supervision and providing teaching in varying styles. The mechanisms through which these action functions are mediated appear incomplete.

3)   THE PATIENT ACTOR

Patients have assumed many roles in medical education and these have been comprehensively reviewed (Towle *et al*, 2010). The clinical learning literature makes consistent reference to patient involvement in student learning as highlighted by Bleakley and Bligh (Bleakley and Bligh, 2008). However students

need to exert action functions in order to locate these patients and this can frequently be problematic (Bell *et al*, 2009).

When students exert action functions and locate patients in the clinical environment, patients can appear to facilitate network initiation through action functions such as undressing and answering questions (McLachlan *et al*, 2012). Monrouxe has highlighted that students and teachers can attempt to exert semiotic functions such as projection of power over patients, for example by giving them limited information in order to gain their consent for participating in learning (Monrouxe, Rees and Bradley, 2009). Spencer develops this argument by highlighting that teaching opportunities often arise serendipitously, and within a short timeframe for completion and so may not provide adequate time for full transfer of appropriate information about consent (Spencer and McKimm, 2010). Buckley suggests that patients may be aware of these complex dynamics and may facilitate learning out of a desire to improve society (Buckley, 2008).

Ethnographic accounts emphasise that patients can interpret the semiotic functions of the clinical environment as dehumanising and can reflect this in action functions that inhibit relationships between learner actor and patient actor. This can be through action functions such as sarcastic remarks or refusal to perform action functions expected of them (Sinclair, 1997, pp. 201-2).

The literature appears to suggest that patients are involved in a complex set of action and semiotic functions that may frequently result in simultaneous facilitating and inhibiting relationships between patient and student actors. This frequently appears to produce ambiguous relationship patterns.

4) OTHER HUMAN ACTORS IN CLINICAL LEARNING

A) JUNIOR DOCTORS

Older, American ethnographic studies describe students maintaining sustained learning networks with junior doctors (Becker *et al*, 1961). Through prolonged attachments to clinical firms with more permanently located doctors, students would follow junior doctors and perform action functions that contributed to both the

function of the clinical service network and development of technical competency such as clerking, blood taking and siting intravenous cannulae. Semiotic functions such as trust and personal relationships built up over prolonged contact, appeared to result in delegation of these action functions.

I have suggested however, that contemporary clinical placements are shorter and that the action function of accessing patients to initiate learning networks can be problematic. Initial observations revealed that clinicians, nurses and external examiners were concerned that students were not performing sufficient action functions associated with technical proficiency. I am interested to investigate what actors, functions and relationships may account for this.

The emerging field of near-peer learning addresses students learning from junior doctors (Bulte *et al*, 2007; Colaco, Chou and Hauer, 2006). These articles describe predominantly short-lived formal teaching activity delivered by junior doctors to medical students, contrasting with the prolonged attachments to junior doctors described above. Action functions associated with technical proficiency such as examination of patients are frequently carried out, with junior doctors providing students with access to patients. These studies highlight the importance of material actors such as social media and communication tools in connecting students to junior doctors.

Table 2.4 demonstrates actors identified through analysis of the literature. Where the literature has suggested relationship properties concerning clinical learning network formation, these are designated in the table: Facilitating (+), Inhibiting (-), Ambiguous (+/-) and intermediary (0).

Table 2.4 Summary of human actor properties

Actor	Action function	Semiotic function
Student	Seeing patients (+) Clerking (+) Performing specific clinical skills (+) Not engaging with learning networks (-)	**Internal** Learning styles • Acquisitional (-) • Participative (+) Negative emotional state (-) Motivation • Projection of disinterest Character traits • Assertiveness (+/-) Knowledge recall (+) Identity as part of clinical team • Develops autonomously **External** Not identified in literature
Consultant	Supervision (+) Teaching through general questioning Specific models of teaching	Enthusiasm (+) Humiliation (-)
Junior Doctor	Finds patients (+) Provides formal teaching (+) Provides immersion in clinical work (US study) (+)	Not identified in literature
Nurse	Finds patients (+) Denies access to patients (-)	Not identified in literature
Patient	Agrees to be seen (+)	Sarcasm (-)
Manager	Not identified in literature	Not identified in literature
Other healthworkers	Not identified in literature	Dismissive attitudes to students (-)

I have previously outlined a classification system for material actors (Knorr-Cetina, 1997) and this provides a structure for interrogating the literature:

1. Instruments (everyday material actors – for example doors or stethoscopes).
2. Objects of knowledge (more complex material actors containing information or knowledge – for example a smartphone with access to the curriculum objectives).
3. Commodities (numeric characteristics – for example numbers of students on a placement, or the price charged for placements by hospitals).

The role of material actors in more general educational contexts (such as blackboards and classroom keys) has been documented in studies of secondary education (Fenwick, 1998; McGregor, 2004; Waltz, 2006). However, some ANT practitioners in secondary education have drawn attention to the relative paucity of these studies:

'the blindness towards the question of how educational practice is affected by materials.' (Sorensen, 2009, p. 2)

Similarly, in medical education the role of material actors seems to have been under-reported. Fenwick has drawn attention to this (Fenwick, 2014) and has examined the role of material actors in the medical school classroom context (Fenwick and Dahlgren, 2015) but not in clinical contexts.

1)   INSTRUMENTS

Clinical learning networks are initiated, maintained and terminated within the service delivery network (Morris, 2012a) and through the process of 'cutting the network' (Strathern, 1996), this study has limited itself to consideration of these two networks. The hospital service delivery network is facilitated by a large number of technical instruments such as computers and mobile devices (Hoffman and Donaldson, 2004). However, in hospital clinical learning networks, many

instruments, have been characterised as inhibitors. For example, Hoffman found that instruments such as bleeps and telephones can project action functionality, by diverting teacher actors (consultants and junior doctors) away from facilitating learning networks to performing necessary action functions required by the service network (Hoffman and Donaldson, 2004). However, this study took place in an American setting that involved students and residents (qualified doctors). It is unclear (from the six hours of ward round observations), to what extent students were present, as their timetable clashed with this activity. In a general practice setting, Rees has suggested that competition for control over instruments such as stethoscopes leads to these instruments acting again as inhibitors of clinical learning (Rees, Ajjawi and Monrouxe, 2013).

2)   OBJECTS OF KNOWLEDGE

I have defined objects of knowledge as an amalgam of material instrument (such as a computer or handbook) and the knowledge held inside (such as curriculum or assessment criteria).

Some of the mechanisms of learning via objects of knowledge have been covered in the technology-enhanced learning literature which was systematically reviewed by Cook (Cook *et al*, 2010). In this study Cook describes mechanisms such as threads, web-based learning modules, and videos to facilitate learning networks. However, in the clinical environment, these delivery mechanisms are dependent on objects of knowledge (such as computers) being functional and accessible to students. The review does not explore the relationships between knowledge objects such as computers and human actors in this context.

Some authors have suggested that objects of knowledge (such as social media software on smartphones) may act as facilitators in network initiation by allowing human actors such as junior doctors and students to contact each other (Bullock, 2014; Dexter and Dornan, 2010). Again, this assumes that these objects of knowledge are functional.

A) TIMETABLES

Timetables represent knowledge that student actors access via a material instrument (course handbook or smartphone) and so I have characterised timetables as objects of knowledge. Several quantitative studies highlight that students seem to spend less time engaged in functional learning networks than may be apparent from the timetables (Dolmans *et al*, 2001; Murray *et al*, 2001; Van-Hell, Kuks and Cohen-Schotanus, 2009; Worley *et al*, 2004). All studies highlight the desirability of supervised contact with patients, but that achieving this goal is problematic. Murray finds that out of an average of 5.5 hours spent per day in the hospital, clinical student actors spend less than 30 minutes with patients. This finding is replicated by Van Hell who finds that 12% of student time is spent in unsupervised patient contact (patient-student actor combination) and 6% on supervised patient contact (patient-student-teacher actor combination).

The literature appears to suggest that supervised patient learning is desirable but quantitative analysis of student self-report data suggests relatively little time is spent doing this. This study seeks to outline the mechanisms that may underlie why this may be so.

B) CURRICULUM

The medical school curriculum at the investigation site consisted of an index clinical case that students were expected to encounter during their week-long clinical placement. Related to this case were knowledge-based learning outcomes. This information was available through the medical school website and access to it was therefore dependent on material actors such as computers, smartphones and functioning connetions. Consequently, I have conceived of curriculum in this instance as an object of knowledge. That is to say a material actor such as smartphone or computer containing curriculum knowledge.

I have previously discussed how some material actors can become intermediaries in clinical service networks; either because they do not work (Ackerman *et al*, 2012) or because the information contained in an object of knowledge does not

form facilitating relationships with other actors – therefore becoming redundant (Smordal and Gregory, 2003).

Dornan (Dornan *et al*, 2007) suggests that clearly specified and tightly defined learning outcomes (such as those used at the observation site) can act as facilitators in network initiation and maintenance. However, non-clinical research from work-place learning (Eraut, 2004b) and knowledge transfer (Nonaka and Takeuchi, 1995; Smith, 2001; Szulanski, 2000), suggests that transfer (or translation) of knowledge into work-place contexts is dependent on knowledge being presented in a way that allows considerable adaption. Work from both these fields suggests that the more tightly defined outcomes are specified, the less adaptable they are to the workplace.

There appears to be debate therefore, around the kind of relationships that the curriculum actor forms in clinical contexts. In some clinical contexts highly specific outcomes have been portrayed as facilitating learning networks, but this does not appear to be the case in other contexts of work-based learning.

C)   ASSESSMENT

In a manner similar to curriculum, I have conceptualised assessment as an object of knowledge, as again at the observation site, assessment practices were encapsulated by a series of forms and statements that were accessed via the medical school website via computers and smartphones.   These assessments were assumed to exert semiotic functionality in motivating student learning. This assumption was based on literature suggesting that assessments exert semiotic functionality, driving learning through the testing effect (Larsen, Butler and Roediger III, 2008). However, at the observation site, summative testing through knowledge tests was expressly not linked to student placements (McHarg *et al*, 2005). Dornan has suggested that summative assessments for medical students frequently do not include workplace assessment and so the assessment actor may exhibit reduced semiotic function in motivating students in the clinical context (Dornan, 2006).

Dornan's findings are corroborated by Morris (Morris, 2012b), who suggests that students can have difficulty in initiating learning networks because of the effects of assessment:

'The tension between preparations for examinations and 'real world' practice also raises questions about the extent to which student practice is aligned to the practices of the communities they join.' (Morris, 2012b, p. 19)

Contrary to its facilitating role in conventional educational locations, it appears that the assessment actor may inhibit clinical learning network formation.

3)   COMMODITIES

Knorr-Cetina suggests that commodities describe the numeric characteristics of actors (Knorr-Cetina, 1997).

There are several studies concerning the numbers of students, patients and teachers and their respective impacts on clinical learning, suggesting that increased numbers of students can inhibit network formation, whereas increasing patient availability and teaching support can facilitate learning (Dolmans *et al*, 2002a; Dolmans *et al*, 2002b; Hoffman and Donaldson, 2004).

The finance attached to medical students may also be characterised as a commodity. Several studies highlight inhibiting relationship characteristics due to reduced motivation if teachers perceive that financial models do not reflect their teaching activity (Bevan, 1999; Clack *et al*, 2001; Peters *et al*, 2009). Dieppe (Dieppe, 2010) has highlighted that this lack of clarity can also affect relationships on a broader scale between hospital senior management and medical school senior management. Previous work (Harding, 2012b) suggested that financial implications of student actor presence in the clinical service network are frequently voiced by hospital managers who control hospital teaching budgets. I was unable to locate a significant literature regarding their role in clinical learning.

Table 2.5 Summary of material actor properties

Key: Inhibiting relationship (-)   Ambiguous relationship (+/-)
**   Facilitating relationship (+)   Intermediary relationship (0)**

Actor	Action functions	Semiotic functions
Instruments		
Stethoscope	Not identified	Projects power (-)
Telephones and bleeps	Divert teachers back to service network (-)	Not identified
Knowledge objects		
Computers	Not identified	Not identified
Timetables	Students report timetable / action function mismatch (-)	Imply student-patient-teacher learning process (supervised participation) (+)
Curriculum	Detailed outcomes facilitate learning networks (+) Detailed outcomes inhibit knowledge transfer to work-based contexts (-)	Not identified
Assessment	Students minimise presence in clinical learning networks to study at home for exams (-)	Drives learning (+)
Commodities		
Finance	Finance reflects teaching activity (+) Finance does not reflect teaching activity (-)	Not identified
Student numbers	Increased student numbers (-) Reduced student numbers (+)	Not identified
Patient numbers	Increased patient numbers (+) Reduced patient numbers (-)	Not identified
Teacher numbers	Increased teacher numbers (+) Reduced teacher numbers (-)	Not identified

The literature on clinical placement learning that I interrogated appears to give emphasis to the internal semiotic functions of the principal human actor (the student). External semiotic projections of students and also their action functions were relatively under-represented. There appears to be less scholarship concerning other human actors such as nurses. Other human actors including hospital managers and other service network staff were not identified in the literature.

The role of material actors in clinical learning appears under-explored. Where literature does address material actors, there appears to be a discrepancy between their facilitating characteristics in the clinical service network, and their relationship-forming properties in clinical learning networks. This analysis of the literature is summarised in table 2.6:

Table 2.6 Relative coverage of actors and functions in clinical learning literature

Actor	Action functions	Semiotic functions
Human	-	+
Material	-	-

2.2.2.3 LEARNING PROCESSES

I have defined learning processes as recurring combinations of student – knowledge-source actors within a learning network. They represent a way of systematically describing the types of student - knowledge-source actor combinations encountered within learning networks.

A network therefore represents a general term denoting sustained facilitating relationships between a learner and knowledge-source actor. Learning processes

describe the specific types of learner – knowledge-source actor combinations that may occur within a network.

As discussed, Dornan has identified several learning processes – each of these implying the sustained presence of a triumvirate of student-teacher and patient and with guided participation as the overall mechanism through which this triumvirate of actors is co-ordinated to produce clinical learning (Dornan *et al*, 2007).

However, literature review and initial observations of student learning in off-timetable contexts suggested that the triumvirate of student-teacher-patient is relatively uncommon and other actor combinations are frequently encountered. A more expansive model of learning processes was therefore necessary to incorporate the different types of actor combinations encountered in the analysis of off-timetable learning and this is outlined below.

1)   OBSERVATION

Dornan (Dornan *et al*, 2007) has examined the practice of students observing (either actively or passively) aspects of the clinical service delivery network. Here it is assumed that the student actor observes the teacher actor interacting with a patient. However, I suggest this process may also refer to instances where the student observes a case conference or business round (Hoffman and Donaldson, 2004), where the patient actor is not present.

I propose observational processes are instances where student and teacher actors may be present but the patient actor may be absent. However, a patient knowledge source-actor is always present. This definition allows for patient actor to be absent, but a material actor (such as patient notes) to take the patient's place.

Initial observations confirmed the presence of student, teacher and patient knowledge-source actors in observational processes. However, the relationships between the student and other actors appeared weak and in some cases absent when compared to other learning processes. I define observational learning

processes therefore as weak or absent relationships between student, teacher and patient-knowledge-source actors.

2) MIRRORING

Dornan's model proposes a further learning process where students begin to copy the work of clinicians (rehearsal). Again, Dornan's overall process of guided participation assumes that this is done under the guidance of the teacher actor. In Sinclair's study however, clerking – perhaps the most common of rehearsal activities – is assumed to take place without the teacher actor being there:

> *'Taking the history is usually done on the official backstage, it being generally assumed that simply asking patients questions is within the student's own competence.' (Sinclair, 1997, p. 201)*

Sinclair also points out that this process does not contribute to participation in the work of the service delivery network – but is usually done to fulfil medical school requirements. Clerking contrasts with 'working up' a patient which is reported in American ethnographic accounts (Becker *et al*, 1961) and implied in later American studies (Hoffman and Donaldson, 2004). Here, students are expected to clerk patients and have knowledge of appropriate investigations and management decisions so that they are able to participate in service delivery network action functions such as ward rounds. This process is not reported in UK accounts and was not observed in my early work. This considerable difference in student roles makes routine comparison of American and British undergraduate clinical learning problematic.

For clarity, I define a process involving facilitating student – patient relationships as a mirroring process. This allows for the possibility of two actors to be present in some learning processes.

3)   PARTICIPATION

'Performance' is the final learning process outlined by Dornan. I have interpreted this to mean that the student participates in the work of the service delivery network and is therefore engaging in supported participation.

I therefore propose to further analyse Dornan's concept of performance through an analysis of some of the literature on participation.

The use of participation as an analytical concept for clinical workplace learning is often attributed to Lave and Wenger (Lave and Wenger, 1991). Lave and Wenger propose that over a period of years, craft-apprentice actors start by undertaking straightforward action functions associated with work (legitimate peripheral participation) and gradually undertake more complex work-related action functions. Through this, apprentices gradually become masters and part of a professional community (community of practice). Lave and Wenger's work focusses on apprenticeship models of learning and I have previously suggested that this type of learning does not accurately portray contemporary clinical placement learning.

In the clinical learning literature, the concept of participation is commonly translated through adopting metaphors such as 'participation in work', 'guided participation' or 'participation in a community of practice' (Boor *et al*, 2008; Dornan, 2006; Hoffman and Donaldson, 2004; Liljedahl *et al*, 2015; Morris, 2012b).

Perhaps the most complete model of participative learning in the clinical context has been developed by Dornan (Dornan, 2006; Dornan *et al*, 2007; Dornan *et al*, 2014). In a series of papers based on extensive literature review and grounded theory analysis of student interviews, Dornan proposes that clinical learning is mediated through guided participation. Through facilitating relationships between student, patient and teacher actors, Dornan proposes that guided participation occurs through learning processes that develop over the course of clinical studies from passive and active observation of work, to mimicking work (rehearsal) and finally participating in (supported) work delivery (performance). This specific form of work-related guided participation (performance) was sometimes encountered in early work. However, student actors often appeared to be operating outside of the

service delivery network and exhibited action and semiotic functions and relationships not consistent with participation in work. I have therefore used participation to denote a specific learning process – or particular actor combinations to account for instances where this was observed. Following Dornan, I have defined participation as:

1. A triumvirate of actors (student, teacher, patient)
2. The student contributes to the work of the service network

However, as guided participation did not appear to always account for all observed learning instances, I have not adopted it as a general principle driving learning. Rather, following ANT, I have defined the overall principle driving learning as the formation of a clinical learning network. In this study, learning networks occur within the boundaries of another network, which is the service delivery network. This study has sought to examine further the relationship between learning as a result of networks, generating particular and specific learning opportuities - and more generalised notions of learning that are assumed to guide or produce learning in a more general sense. Through this process, I hope to clarify the role of participation and / or other processes such as learning networks in clinical learning. In summary, I have adapted Dornan's performance process to represent particular instances where students engage in guided participation in work. That is to say that I have defined a participative process as instances where student, teacher and patient appear to engage in work. Defined in this way, guided participation did not appear to account for all instances of off-timetable learning and this study has sought to articulate additional mechanisms that can contribute to understanding how medical students learn in these circumstances.

4) TEACHING

In order to account for the practice of clinical teaching, I propose to add a further learning process to Dornan's typology. Initial observations confirmed that often teaching would take place without the presence of a patient. I define a teaching process therefore as a combination of student and teacher actor that may or may

not also involve a patient or patient knowledge-source actor. Observational processes may contain the same combination of actors – however teaching processes were characterised by stronger relationships between student and other learning network actors.

5)   DISSOCIATION

The literature appears to point to certain action functions employed by students that minimise their participation in clinical learning networks (Sinclair, 1997, p. 133; White *et al*, 2014). In these circumstances, student actors form facilitating relationships with knowledge-source actors that are not patients or teachers (for example text-books). Additional action functions may be necessary in order to do this that may impact on clinical learning network formation for other students. For example, initial observations revealed that students may ask other students to sign in for them or tell teachers that they are ill. Students that demonstrate dissociative processes also exert semiotic functionality on clinical learning networks. For example, teachers are frequently suspicious of students who claim illness and can extend semiotic interpretations of disinterest from one student as applying to the whole group of students present on a placement (Sinclair, 1997, pp. 236-8).

6)   SUMMARY

The learning processes adapted from Dornan's work (Dornan *et al*, 2007), provide an analytic category that captures the range of actor combinations encountered in the literature and initial observations and is summarised in table 2.7 overleaf:

Table 2.7 Summary of learning processes

Learning process	Actors
Observing	Student – teacher – patient-related knowledge source (patient, patient notes, patient results) Weak or absent relationships
Mirroring	Student – Patient
Teaching	Student – Teacher (+/- patient actor) Stronger relationships than observing processes.
Participation	Student – Teacher – Patient Stronger relationships than observing processes Contribution to delivery of work
Dissociative	Student – Non-patient related knowledge source

2.2.2.4 LEARNING NETWORKS

I have defined a learning network as sustained facilitating relationships between student and knowledge source actor(s) (teacher, patient, computer) – but with the caveat that other actors may play substantial roles that can serve to influence this fundamental relationship. This is because the triumvirate of student-patient-teacher actors implied as being present in other depictions of learning networks, appears infrequent in quantitative accounts in the literature and was rarely encountered in initial observations.

Networks in work-based learning and clinical learning literatures are often demonstrated through conceptual diagrams, with relationships between relevant actors articulated through lines of linkage (Dornan *et al*, 2007; Evans *et al*, 2010; Illeris, 2009b). However, the nature of the relationships between the actors implied by these lines of linkage is often unclear. Dornan's model of clinical learning is perhaps the most well known and I have described the learning processes involved with this model. Dornan outlines a number of human actors that may contribute to these learning processes (patients, doctors, nurses and peers) and also identifies material knowledge source actors such as curriculum outcomes and material commodity actors such as student and teacher numbers and time spent on clinical

placements. Dornan now proposes relationships between this collection of human and material actors through lines of connection, suggesting that the relationship between human actors and the learning processes is through support. Dornan's model therefore begins to establish relationships between some human and material actors to form a coherent model of clinical learning that produces two main outcomes. Firstly a positive state of mind and secondly, practical competencies such as study skills, applied knowledge and clinical skills:

Figure 2.1 Relationship between actors, processes and network outcomes (Dornan *et al*, 2007)
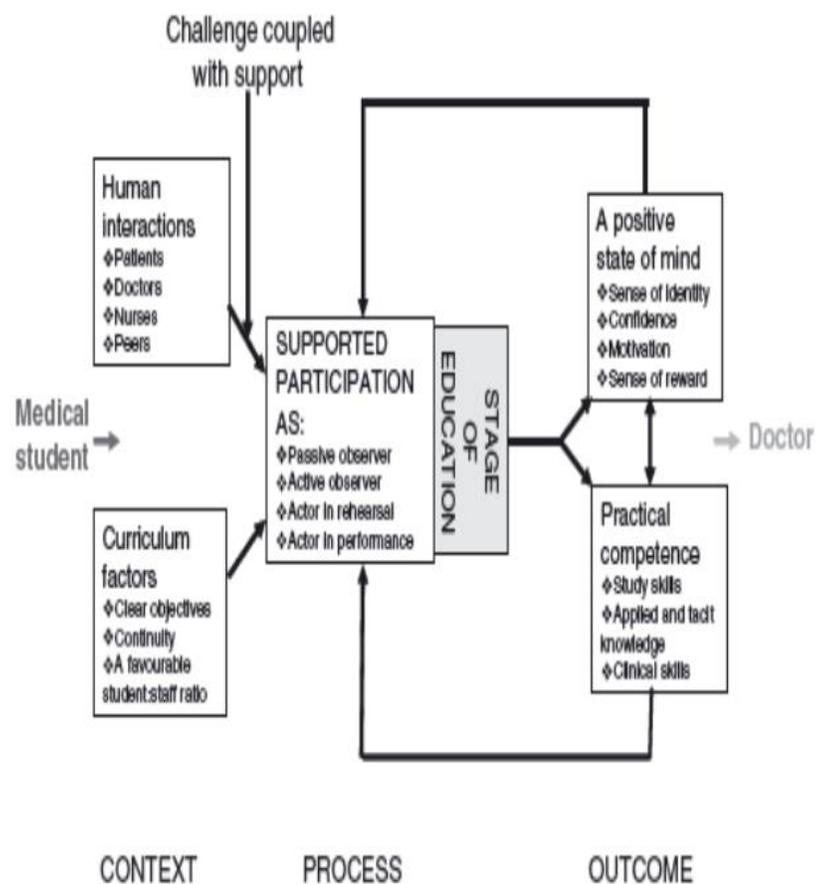
My ANT literature review and early observations have indicated other human and material actors, functions and relationship mechanisms that may add detail to this model.

Dolmans (Dolmans *et al*, 2002a) has used a different method to establish relationships between actors in a formal learning network (outpatient clinic). Here, Dolmans uses student ratings of some material actors to statistically quantify the facilitating or inhibiting relationships between these actors. Dolmans proposes that supervision and an appropriate mix of patients facilitate learning networks but that the number of student actors does not inhibit network formation. This approach begins to outline some of the mechanisms underpinning clinical learning by making statistical linkages between some of the human and non-human actors, represented as a diagrammatic model (see figure 2.2).

Figure 2.2 Statistical associations between some human and material actors (Dolmans *et al*, 2002a)
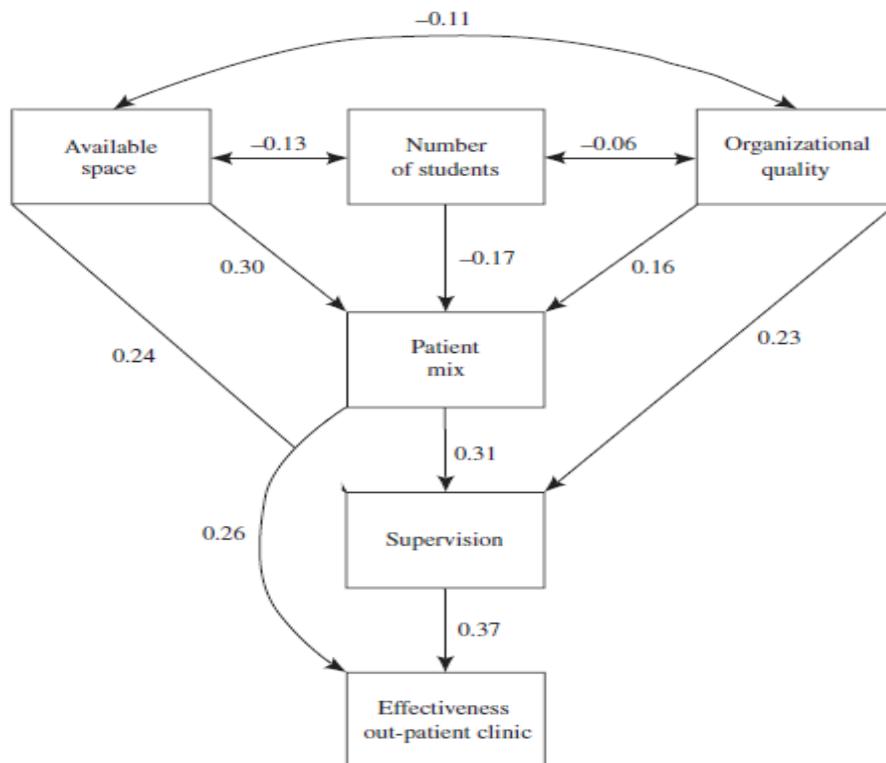
However, observations of students in off-timetable settings suggest that student numbers impact substantially on access to patients and that patient mix is not a variable that students are able to control. Dolmans proposes supervision from a clinician actor as the overarching facilitating relationship in network formation, but the relationship between the overarching facilitating relationship and the statistical relationships between the actors is unclear.

Both studies do not interrogate specifically the off-timetable context and I have previously argued that in off-timetable learning, supervision may not be present and therefore another method of establishing relationships between actors in networks may be necessary in this context. In addition, both studies represent relationships between actors in diagrammatic form; implying a permanence of network relationships that may not accurately reflect the variety of relationships between actors or the rapidity with which they may change.

This study has sought to add some of this detail by exploring how a systematic language of relationships between human and material actors can be utilised.

2.2.2.5 NETWORK OUTCOMES – LEARNING TECHNICAL PROFICIENCY

ANT conceives of learning as the outcome of a network of actors and their relationships. Many accounts of clinical learning focus on how students learn attitudes and professional behaviours. In this account I focus on how students learn technical proficiency which I have defined as a combination of clinical skills and clinical knowledge. I have not attempted to measure what students learn - rather I am interested to see how learning opportunities are generated and what opportunities they may afford.

1)   LEARNING CLINICAL SKILLS

Clinical skills include practical and communication skills necessary for practice as a junior doctor. There is a large body of research relating to learning these skills in simulated environments, emphasising the importance of guided feedback (Aspegren, 1999; Bradley, 2006; Kneebone and Nestel, 2005). However, initial

observations suggested that guided feedback seldom took place in the clinical environment (Harding, 2012b), and that learning processes may be considerably different to those in simulation centres. Eraut (Eraut, 1994; Eraut, 2004b) has argued that there is often dfficulty in transferring skills from university settings to work-place settings and the clinical literature regarding the transfer of university-derrived PBL skills, to clinical settings seems to support this (Albanese and Mitchell, 1993; Norman, Dore and Grierson, 2012).

In the clinical environment, some research has focussed on developing lists of desirable skills (Dacre and Nicol, 1996) for students to practise clinically. However, several studies comment on the difficulty in accessing patients or participating in work specifically relating to practising and developing clinical skills in the hospital environment (Celenza, Li and Teng, 2011; Colquhoun *et al*, 2009; Widyandana *et al*, 2011). Several authors suggest that the culture or learning environment of hospitals serves to make learning clinical skills challenging (Jackson, Wall and Bedward, 2012; Talbott *et al*, 2012) with clinical staff being portrayed as cynical of the idealistic way in which students initially approach clinical examination of patients.

In addition, discrepancies in clinical skills teaching between the medical school and the clinical environment are highlighted (Widyandana *et al*, 2011). Krautter (Krautter *et al*, 2014) finds that tailored instruction concerning negotiating specific learning environments within a hospital can increase students' chances of success in accessing patients. In his study, medical students received instruction on ward round etiquette. Subsequent learnng performance on ward rounds was significantly better than peers with no initial instruction.

In summary, medical schools facilitate technical competence acquisition by providing opportunities to practise clinical skills in simulation centres (Bradley, 2006) and by providing lists of desired clinical skills to practise in the clinical environment (Dacre and Nicol, 1996; Talbott *et al*, 2012). However, a number of inhibitors are described in the literature that may make clinical skills practise challenging in clinical learningnetworks. These include the semiotic influence of cynical culture, a material commodity of patient scarcity and students perceiving

that the skills learned in simulation centres do not translate into the clinical environment. The lack of translation of medical school network actors (such as curriculum) into the clinical service network has been discussed in previous sections.

Laboratory-based research recommends both student, teacher and patient (or other knowledge source) are present to optimise learning through guided feedback. As teachers were commonly absent in off-timetable learning, this study interrogates to what extent skills learning is possible in this context.

2)   LEARNING CLINICAL KNOWLEDGE AND REASONING

Some authors have questioned the role of pre-clinical scientific knowledge in the development of diagnostic reasoning in clinical students. Schauber finds that increasing amounts of pre-clinical knowledge 'crowds out' the ability to learn clinical knowledge such as diagnosing diseases and their relevant treatments (Schauber *et al*, 2013).   These findings challenge assumptions made in some influential models of reasoning used at the study site that are based on the reasoning strategies of experts (Schon, 1983). In Schon's reflective model of expert professional action, cases where conscious deliberation is necessary are dealt with by application of pre-existing foundational knowledge. Schauber's study raises questions about whether models of professional reasoning based on the actions of experts are applicable to novices, and challenges the assumption that pre-clinical science knowledge is necessarily integrated into novice reasoning in clinical contexts.

Other models suggest clinical reasoning is based on prior experience of clinical cases - known as the script (Charlin *et al*, 2007; Eva *et al*, 2007) or prototype model (Bordage, 2007). However, junior medical students do not have access to scripts or prototypes as they are by definition novices with little or no prior experience of cases.

Some authors therefore suggest a mixture of analytic models and experience based models (Eva *et al*, 2007) for medical student instruction.

Studies concerning clinical reasoning frequently use diagnostic reasoning as a marker for clinical reasoning in general (Bordage and Lemieux, 1986; Eva *et al*, 2007). However, Atkinson (Atkinson, 1997) points out that students are not presented with patients in the pre-diagnostic phase in hospital. I also suggest that the role of diagnosis may have changed with the advent of advanced imaging and other diagnostic tests. It is therefore possible that other clinical reasoning skills may be relevant to patients with established diagnoses and chronic diseases, as these account for the majority of hospital patients. I could not identify a literature that addressed these aspects of clinical reasoning.

2.2.3   SUMMARY

An adapted ANT interpretation of the clinical learning literature highlights a number of reported human and material actors, but identifies the potential contribution of a substantial number of further actors – in particular material actors.

The literature characterises the student actor in some detail and emphasis is given to internal semiotic functions. There is less emphasis on external semiotic functions or the action functions that students exhibit to form learning networks. Initial observations indicate the potential for these to contribute substantially to network formation.

Combinations of actors may form learning processes and a number of these processes are identified in Dornan's influential work (Dornan *et al*, 2007). Dornan proposes that three actors are always present in learning processes but this was not always seen in initial observations. Dornan's learning processes have therefore been adapted and expanded to include the additional actor combinations encountered in the literature and initial observations.

Facilitating relationships between a student and knowledge-source actor are a fundamental characteristic of learning networks but other actors can significantly influence this relationship. The depiction of a relationship within networks is often characterised by diagrammatic lines, where the precise nature of the relationship is not clear. There may be potential to add further detail to actor relationships within

networks through the use of a systematic vocabulary to describe human-material relationships.

'Participation' is a dominating concept or metaphor in accounts of clinical learning (Dolmans *et al*, 2002b; Dornan *et al*, 2007; Dornan *et al*, 2014). However, the detail of the what and how of 'participation' in the context of undergraduate clinical learning is arguably not sufficiently understood. This study seeks to examine whether the adapted ANT framework is a useful way of adding to this understanding. Furthermore, other learning processes may account for the substantial proportion of time that students appear to spend engaged in learning that is either unsupervised or not involving patient contact (Dolmans *et al*, 2001). This study additionally sought to examine how this learning occurs, in order to provide a more comprehensive understanding of clinical learning.

CHAPTER 3 – METHODS

3.1   INTRODUCTION

This chapter has three purposes: firstly, to operationalise a contemporary socio-material theory (ANT) into a set of methods and analytic tools, capable of interrogating and analysing a socio-material environment such as a hospital. The second purpose is to demonstrate how I have used this approach to answer the research question. The third purpose is to provide an account of how my position as a curriculum designer and change agent influenced this process.

3.2   METHODOLOGY

I was unable to locate contemporary observational studies or studies regarding off-timetable learning, or studies that had employed ANT in contexts. The study was therefore primarily exploratory.

My approach was influenced by the work of John Law whose book 'After method' (Law, 2004) describes how ANT practitioners approach elements of methodology. Law, in keeping with post-structuralist thinking, questions existing hierarchies, suggesting that often these perpetuate power structures (Law, 2004, pp. 4-10). This sceptical stance to the authority of external sources and accounts manifests itself in several important ways concerning ANT methodology.

Firstly, ANT adopts a sceptical stance to reported behaviours such as information derived from interviews or questionnaires. Scepticism towards the reported behaviours of medical students has been documented in the clinical learning context by Becker. After eight years of student observations and interviews, Becker discarded all medical student interview data because of the differences between interview accounts and observed behaviours (Becker *et al*, 1961, p. 445). Sinclair's ethnographic work (Sinclair, 1997, pp. 103-8) suggests a plausible explanation for why the discrepancy may be magnified in medical students.

Sinclair proposes that clinical students find themselves at the age of at least 20 (when their other friends are starting paid employment), unqualified and at the bottom of a clinical hierarchy. They are required to give up long holidays and study hard with no financial reward and mounting debts, for a further two or three years. In order to justify these circumstances, Sinclair suggests clinical students adopt an over-optimistic assessment of their environment and an over-identification with their chosen profession. As a consequence, Sinclair suggests that clinical students may not always give an accurate portrayal of their learning environment. Internal evaluation data at the study site confirmed a consistent divergence between student reports of clinical firms for evaluation purposes, and observed behaviour (medical school internal documents).

Most ANT studies are therefore heavily reliant on approaches involving direct observations of behaviour such as ethnographic approaches. I adopted observation as the primary data source, as I am primarily concerned with analysing the actions of human and material actors. However, I am aware that my descriptions and interpretations of student actions are no more than another report of behaviour and are not impartial.   I have addressed potential personal biases firstly in a previous chapter by stating clearly my own position in relation to the study and secondly in this chapter, I have outlined clearly the process I have used to collect and analyse the data.

This open approach to describing methods raises a second, broader issue that concerns ANT's sceptical approach to conventional methodology as a vehicle for advancing truth or knowledge claims. Early work in ANT (Latour, Woolgar and Salk, 1986, pp. 236-44) suggested a certain artifice in the generation of scientific knowledge. Through observation of laboratory work, Latour became aware of social processes influencing outcomes of scientific work. Researchers did not move from one logical premise to another isolated from social contact, but were subject to inspirations, conversations and conspiracies in coffee rooms and conferences which influenced researcher thinking. Furthermore, Latour found the logical descriptions of method advanced in the final scientific articles, did not match the more chaotic conditions he observed in the laboratory. Law extends this

thinking to suggest that as methods are the vehicle by which knowledge claims are justified, it may be illogical to apply simple clear methods to complex phenomena. He argues that this approach can produce accounts of complexity that have been 'distorted into clarity' (Law, 2004, p. 2).

Many ANT studies do not therefore articulate a clear method or analytic process, advancing the argument that for complex, messy phenomena, the power of the description represents both the method, result and conclusion – and that readers are free to interpret this in a variety of ways (Mol, 2002, pp. 1-27). This approach raises a number of methodological issues that have been the subject of a sustained critique of ANT methodology (Bloor, 1999; McLean and Hassard, 2004) and are relevant to the development of methodology for this study.

Firstly, I have previously outlined that both socio-cultural and socio-material approaches are well-developed theoretically, but often do not offer methodological or analytic tools for novice researchers (Morris, 2012a). This may limit the uptake of these approaches by researchers. It may also limit the readership of ANT articles in specialties such as medicine, which historically adopts clear methods. The medical field represents a target audience for this work and so a clear description of methods may be beneficial.

Secondly, the presence of social influences in scientific methods does not necessarily invalidate the need for describing those methods. I suggest it infers that descriptions of method should be open about influences. I therefore adopted a reflexive approach to describing the method of data collection. That is to say, where possible I have been open about the external influences on my own data collection and analysis.

Thirdly, an opaque methodology makes repeatability and critique (and thereby advancement of knowledge in a conventional sense) difficult. Furthermore, lack of a clear analytic approach can make it difficult to understand how conclusions are derived from original data - for descriptions carry a number of explicit or implicit interpretations of what has been observed.

Finally, McLean (McLean and Hassard, 2004) suggests that it is possible that even experienced observers such as Latour may not fully capture or reproduce the

intricacies of professional practice.   When Latour observes elements of disorder in a laboratory (Latour, Woolgar and Salk, 1986, pp. 43-53), this does not necessarily imply that the knowledge generation process is disordered. Deductive reasoning, rechecking data and peer review are parts of quantitative research that Latour may not have observed or were hidden from him. This phenomenon may apply to observations of medicine, which is highly technical and (often for confidentiality reasons) notoriously opaque in what it reveals to the external world (Atkinson, 1997, pp. 13-4 and 136-8). It may be that observers do not perceive correctly, or reproduce completely all that they observe (McLean and Hassard, 2004). I therefore draw cautious conclusions from observations.

For the reasons above, I propose to break with this aspect of ANT methodology and articulate a clear method for data collection and analysis.

3.2.1   EHNOGRAPHIC APPROACH

In order to observe human and material actors in learning networks, I adopted an ethnographic approach to data collection, broadly following the approach of Hammersley (Hammersley and Atkinson, 2007). Ethnography is the preferred method of ANT data collection as it involves direct observation of actors and relationships as they occur, within their natural environment (Mol, 2002). Ethnography is also congruent with post-structuralist approaches such as ANT, as it gives voice to multiplicity - multiplicity in terms of the many disparate actors and relations that typify many complex phenomena – but also multiplicity in presenting a variety of interpretive possibilities. This approach therefore avoids totalising or singular interpretive accounts or metaphors (Law, 2004, p. 8).

Ethnography carries with it implications of prolonged immersion to fully appreciate the social and cultural environment of the study site (Hammersley and Atkinson, 2007). However, many ethnographies do not start with a clear research objective. In this instance, I have elected to use a certain perspective (ANT), to observe a particular part of student clinical learning (the process of learning technical proficiency during off timetable learning). Because of this more focussed

approach, I suggest it may be possible to adapt the approaches outlined by Hammersley and others and substantially reduce the time spent in the research environment. This approach has previously been used by Morris (Morris, 2012b). A drawback of this approach may be that a comparatively small number of actors and relationships are observed over a comparatively short period of time resulting in accounts that do not convey the richness of traditional ethnographies and lack the convincing descriptions resulting from long-term immersion.

3.3 METHODS

3.3.1 PRE-OBSERVATION

3.3.1.1 FOCUS GROUPS

I carried out five focus groups of between five and eight students from all three clinical years following standard approaches described by Liamputtong (Liamputtong, 2011). Focus groups were for triangulation purposes, but also to enable sensitisation to particular issues. I recorded and transcribed the interviews and carried out a thematic analysis. Emergent themes included students withdrawing from clinical learning and student difficulties in getting to see patients. These themes influenced my approaches to observation. For example, in order to speak to students who had dissociated from clinical learning, I engaged in snowballing recruitment whilst observing students. This process involved routinely asking student actors about student dissociation during observations. Through this method, I was able to contact several students who were happy to talk to me about this.

3.3.1.2 PILOT OBSERVATIONS

Based on the results of the focus groups, I carried out a day of pilot observations in order to acquaint myself with the observation environment and to review observation strategy. I had initially planned to observe student learning from the nursing station on the chosen ward. However, it became apparent that students

moved about the hospital more than I expected, and this altered my observation strategy. This resulted in different technical needs, such as a smaller observation notebook and a smaller mobile computer.

3.3.1.3 CURRICULUM DOCUMENTS AND OTHER ARTEFACTS

I collated curriculum documents and performed thematic analysis. The methods employed are described in detail in a previous study (Harding, 2014).

Analysis of curriculum documents and the timetable of students under observation enabled planning of the most effective times for observation. In addition, curriculum documents and other artefacts such as quality monitoring and assessment data were instructive in developing my analytic framework.

3.3.2 OBSERVATION

I carried out quasi-participant observation of year three students for a day a week (Tuesday) on a single paediatric ward. Observations ran to a total of thirty days over a two-year period.

3.3.2.1 RATIONALE

I carried out quasi-participant observation of third-year student learning as I am interested in documenting the activities relating to acquiring technical proficiency. I participated in student activities such as ward rounds, finding patients on the ward, helping junior doctors and going for coffee in the canteen. However, I am not a student and made my position clear as a researcher, and so remained outside their closer cultural environment. As such, it is not possible to claim that I was directly observing phenomena whilst being a member of a group, nor is it possible to say that I was completely outside the group. I therefore adopt the term 'quasi-participant' (Guell and Ogilvie, 2015) to reflect this position accurately.

I was interested to examine the role of quasi-participant observation as a method of describing how contemporary students learn technical proficiency. I suggest this approach allowed me direct access to the relevant human and material actors and

allowed observation of their functions and relationships inside (and outside) learning networks.

Criticisms of observation include the effect of the observer on the actions of those being observed – the so-called Hawthorne effect (Bristowe and Patrick, 2012; Snow, 1927). I have significantly altered observation strategy to take this into account. Firstly, as outlined, I altered observation strategy to ensure Tuesday as the observation day. This gave me an opportunity to be present on the first day of the student attachment. I then attended the introductory session and accompanied the students to coffee afterwards. This gave students ample time to ask further questions about the purpose of my study. I attended student social nights at their invitation and also attended lectures and other teaching activities during the day that were not the focus of this research. I aimed therefore to desensitise students to my presence. I am also aware of my own medical student background and the cultural heritage shared by students of medicine and used this to a limited extent to integrate myself. In addition, I have received feedback through peer analysis of my clinical verbal and non-verbal behaviour via video analysis for the past 20 years and feel this may have contributed to increased sensitivity in clinical areas.

3.3.2.2 LOCATION

Observation was based on one paediatric ward at one hospital, for one day a week, over a period of two years. A total of thirty observation sessions took place. The reason for limiting my choice to one ward is that many contemporary theorists emphasise the centrality of social and cultural considerations in work-place learning   (Ellstrom, 2011; Engestrom, 2009; Eraut, 2004a; Lave and Wenger, 1991). I aimed to become thoroughly familiar with the detailed human and material interactions that may comprise these social and cultural considerations and I hypothesised that this would be difficult if observations occurred in different locations or for short periods.

Previous observational work on sociocultural influences in clinical learning has the drawback of very limited enculturation because of limited time spent at the

observation site (Morris, 2012b). More extensive observations have consistently noted the veiled and ambiguous ways (Atkinson, 1997, p. 189) in which the 'theatre' (Sinclair, 1997, p. 32) of medical student teaching is constructed. I concluded that in order to better understand these findings, a more thorough knowledge of one location was preferable to a more superficial understanding of several – where the detail of subtle or veiled interactions may be missed.

Other options would have been to observe learning on many wards, or in many hospitals in the hope of better generalisation of results. However, this is an exploratory study, aiming to identify, and systematically describe and analyse the microstructure of clinical learning encounters. These include human-human functions and relationships that may help delineate at a micro-level the broader socio-cultural phenomena such as behaviours. I concluded that a detailed examination of a single location was preferable and this is consistent with the approach taken in other ANT ethnographies (Latour, Woolgar and Salk, 1986; Mol, 2002).

I chose a paediatric ward for several reasons. Firstly, I had previously established good working relations with staff. Secondly, paediatrics enjoys an enviable reputation at the hospital for its teaching quality - based on a more structured timetable for clinical students than most other departments (internal medical school documents). I wanted to observe good educational practice if possible. I also wanted a timetable that allowed me to spend time with students doing formal structured activities before unstructured off-timetable learning activities. This is because students appeared to find off-timetable learning more difficult. They were frequently unsuccessful and found this embarrassing, making observation difficult. I suggest that this difficulty in observation partially accounts for a lack of data regarding off-timetable learning. The structure of the particular paediatric teaching timetable on the observation day made such observations possible – but after a period of more formal learning which students found less threatening.

I chose third-year students because they are crossing the threshold from pre-clinical to clinical learning. They are learning to negotiate the human and material actors within the service delivery network that are also part of their own learning

network. I propose these challenges may be more apparent to the observer at this stage and in this way may help to highlight more clearly the relevant actors, functions and relationships involved in learning network formation.   In more senior student actors, these considerations may have become encapsulated as tacit knowledge and therefore more difficult to observe and for students to retrieve from memory.

3.3.2.3 ACCESS TO OBSERVATION SITE

The length of observation (thirty days in two, fifteen-week periods), was influenced by difficulties in access to the observation site. I approached senior consultants and nurses eight months before observations took place. After presenting at an academic meeting, informal permission was granted.

Formal access was more problematic, as the hospital required ethical approval for the study before issuing an honorary contract. Unfortunately, one of the University ethical committees required this honorary contract before their decision about ethical approval could be made.

The study was required to pass through three ethical committees before commencement (hospital, local medical school and degree-awarding university). Two of the institutions required peer review. Once ethical permissions had been obtained, an application for an honorary contract was made. Unfortunately, this was lost in administrative offices. Before commencing observations, I was required to have additional criminal record checks and attend appropriate health and safety, fire and manual handling training. Finally, an access card was issued but this didn't work initially.

Access to the clinical environment presented a considerable hurdle and may also explain the relative lack of observational studies in the clinical environment.

3.3.2.4 SAMPLING

I observed student learning for one day a week for two blocks of fifteen weeks. I also undertook a week of intensive observation at the beginning of observations to better understand how a student week was comprised. The two blocks were located at the beginning and the end of the student year. This approach gave good coverage of student development over their first clinical year. As attachments were for one week, I had the opportunity to observe many students. An alternative would have been to follow a smaller number of students as they rotated through different wards. As discussed, I was interested in the detailed socio-material actors and linkages regarding their learning and elected to stay at one site where these factors could be better understood.

Off-timetable learning accounted for the majority of time spent by students on the paediatric ward. On other wards, it accounted for almost all the learning time. Students were generally encouraged by clinicians to use this time to clerk patients, practise relevant clinical skills and present findings to fellow students in order to develop clinical reasoning skills. Curriculum documentation referred to this time as 'SDL' (self-directed learning), however, no further elaboration about intended outcomes or learning activities was made. This time was rarely discussed either by staff, or students and was therefore largely hidden from view.

The method of observation has been focussed on illuminating this somewhat obscured learning practice, through direct and repeated observation of multiple students undertaking this learning.

3.3.2.5 DATA COLLECTION

During observations, I kept a detailed log of events. As outlined, in order to de-sensitise students to my presence, there were times when I was present as an observer but the learning activity was not of immediate interest (for example, lectures). At these times I transferred notes to a password protected and encrypted laptop computer (Lenovo S206).

I also collected student accounts of their learning via informal interviews at the site of learning. This acted to triangulate observed behaviours and also gave an insight into what students thought they were learning regarding their clinical reasoning and knowledge. I used a password-protected i-phone 5 for this (voice-memo). I also used the i-phone to take pictures of different environments. This was useful at times in highlighting the extent of material actor involvement in student learning. At the end of each day of observation, I completed notes and started to make comparisons with previous notes and ideas. In this way, data collection and analysis progressed in tandem.

3.4   ETHICS

My ethical approach to this study was informed by British Educational Research Association (BERA) and General Medical Council (GMC) guidelines regarding research (British Educational Research Association, 2011; General Medical Council, 2010).

3.4.1   PARTICIPANT CONSENT

A major ethical issue concerns the consent of students and patients to take part in the study, as it is possible they may have felt obliged to participate due to my management role. A number of adaptions were therefore made to take this into account.

I obtained written consent from students at the start of each week (see appendix 2). Before I did this, I e-mailed the students attaching an information sheet (see appendix 3). The e-mail did not contain my signature and was generated by the administration office at the school. The e-mail gave the students an opportunity to decline without having to reply to me directly, which I felt might exert undue pressure to take part. In the event of a student declining to be observed, I had planned to observe fourth year students. No students declined to participate. Patients (the children on the ward and their parents) were not aware of my role as both physician and researcher. Despite my position as a physician, I felt it

important that patients knew my role as researcher. Consent issues were therefore individually negotiated in the different clinical situations. For student-initiated interaction with patients (clerking), I introduced myself as a researcher attached to the clinical team. For consultant-initiated contact, such as ward rounds and clinics, I asked the clinician seeing patients to introduce me along with the medical students. In this way, I hoped to make my role clear. I judged patient consent forms for each interaction impractical and suggest that I was observing day-to-day interactions between patients and clinicians for which consent is not usually required.

3.4.2 ETHICAL IMPLICATIONS OF MANAGEMENT ROLE ON OBSERVATIONS

My clinical and managerial responsibilities also raise issues regarding my duties as a doctor concerning patient care and management responsibility for teaching quality at the medical school.

Firstly, as a middle management figure, I had considered the possibility of observing sub-standard teaching or poor student behaviour. I have dealt with both issues over the past ten years and felt I would be able to respond appropriately by making appropriate comment or taking further action through the appropriate channels. In the event, no such issues arose, although I felt it necessary for both teachers and students to be aware of this responsibility. I communicated this via information sheets (see appendix 3). Information sheets were also e-mailed to all members of the paediatric ward staff before I started observations.

I also considered the possibility that I might give students and teaching staff an impression that I was evaluating teaching or learning performance. To address this, I explained that part of the rationale for the work was to try and improve curriculum delivery at the school, through a better understanding of how it was enacted in practice. This was a particularly effective way (for example in coffee room conversations) of ensuring access to off-timetable learning situations. I have endeavoured to articulate study findings in a manner that is not evaluative of teaching or learning practice. To ensure this, I have presented research findings to

students and clinicians at the research site. I have also discussed ongoing findings with a senior clinician at the site to ensure my interpretations are not perceived as evaluative of teaching or learning.

Finally, I considered my duties as physician. I did make it clear that if a situation arose where patient safety was compromised I would have a duty to act. Again, no such issues arose.

3.4.3 INSTITUTIONAL CONSENT

Ethical approval was granted by the University of Exeter Medical School ethics committee (see Appendix 1). Prior to this, additional ethical approval was also required by the Institute of Education, London and The Royal Devon and Exeter Healthcare Trust.

3.5 ANALYSIS

I carried out a two-stage analytic process. Firstly, a prolonged iterative analytic process that developed throughout data collection. Here, a hermeneutic process (Crist and Tanner, 2003), took place between detailed description of observations and subsequent comparison to relevant literature and a developing analytic framework. The second phase took place when data collection and generation of the conceptual framework was complete. At this point, detailed analysis of selected vignettes took place using the analytic framework, together with the ANT analytic method of assemblage (collecting all relevant actors, ascribing no priority to any) as previously outlined.

3.5.1 AIMS

This is primarily exploratory research, gathering qualitative observational data with the intention of generating detailed description and analysis. I therefore adopted an inductive approach to analysis. The aim of the analysis is to generate interpretive descriptions that take into account a large number of actors and actor

relationships. Through this process, I hope to provide an answer to the research question that is theoretically informed and grounded in empirical observation.

3.5.2 STRATEGY

3.5.2.1 STAGE 1 INITIAL ITERATIVE ANALYSIS DURING DATA COLLECTION PHASE

I used analytic methods that were capable of integrating disparate actors, functions and relationships, in order to generate cohesive descriptions of how clinical learning takes place.

Here, I made extensive use of memoing as described by Denzin (Denzin and Lincoln, 1994). In this way initial observation notes were coloured by my own initial thoughts about potentially relevant actors and relationships, together with ideas gleaned from the literature. I checked and developed these emerging thoughts through interviews with students.

As observation notes built up, I made use of the constant comparative method as defined by Strauss (Strauss and Corbin, 1998). By looking at previous accounts, emerging actor properties could be compared and consequently developed. Sometimes, this method led to emerging interpretations being discarded. Observations continued in tandem with reading and development of an analytic framework and observation notes reflected this. As observations and reading reached a conclusion, I therefore increasingly adopted a hermeneutic principle, alternatively looking closely at the text of observations and interviews but also considering how each observational passage related to developing conceptual frameworks. This approach has been used in nursing health education research (Crist and Tanner, 2003; Diekelmann, 1993) and I increasingly adopted this approach as observations neared their end.

Again, following the hermeneutic approach outlined by Crist and Tanner (ibid), I now looked for examples (or vignettes) in my observation notes that epitomised a recurring set of relations present in the data.

I subsequently checked emerging interpretation of vignettes with students and staff at the ward via presentations at successive meetings.

3.5.2.2 STAGE 2 FORMAL ANALYSIS OF VIGNETTES

I now subjected vignettes and their nascent interpretations within the observation notes to a separate analysis using the analytic framework outlined in chapter two. Here, I applied a more systematic approach to analysis, ensuring that for each vignette the actors, their linkage properties (functions and relationships), network patterns and resultant technical proficiency learning was considered.

In summary, I have followed the approach of Morris (Morris, 2012b) in using a bespoke combination of analytic methods selected for a particular purpose (establishing relationships between actors).

3.5.3 PROCESS

3.5.3.1 STAGE 1 INITIAL ITERATIVE ANALYSIS DURING DATA COLLECTION PHASE

The first part of analysis started with note taking during observations. Where I discerned potential actors, relationships or network types I highlighted these. A dialogue existed therefore, between documenting observation and early interpretation.

A further analytic process took place in transferring handwritten notes to computer. Initially, I did this with N-Vivo, but I found this programme encouraged premature coding practices and did not allow for a sufficiently rich set of observation notes to develop and so I abandoned this method.

Instead, I used coloured fonts in Word – using separate colours for observations, and connections with the literature. This is demonstrated in the exemplar vignette below. As observations proceeded, I also used separate systems to denote networks, actors and relationships.

Over the observation period, predictable actor properties and relations began to emerge (such as the role of material actors as inhibitors). Increasingly, sets of

actor-relations became apparent – joining several actors and types of relationship. Where an observation seemed to demonstrate this with particular clarity, I labelled it as a potential vignette and highlighted the relevant text. In this way, potential vignettes could easily be identified among the other observation notes.

I then carried out an initial ANT analysis of identified vignettes. Using the ANT approach of assemblage (Law, 2004, p. 41), I initially listed all possible components and linkage possibilities. The following exemplar vignette and its associated interpretation (in early stages) demonstrates this process. In these initial analytic stages, I used colours to highlight observation (black), my emerging thoughts (blue), material actors (red) and human actors (green). I highlighted technical terms in bold and these are explained in the Glossary.

3.5.3.2   EXAMPLE OF VIGNETTE ANALYSIS – 'WHERE IS S?'

In this vignette, a group of students have just finished a formal teaching session at the medical school building and have arranged to meet on the ward. The students have just been let into the ward, as their access cards do not permit access.

1.30 S (a student) hasn't showed up so we try and text him, but there isn't any mobile reception. This must cause a heap of problems?
1.35 So we go to another part of the ward
We try and text S again, but there is no reception here either
The entrance bell goes to the ward, we think it may be S but we can't work the system to let someone in - but it's a student nurse. One of the students says; *'the student nurses always seem to be busy'.*
1.39 We give up waiting for S and go to another ward and sure enough the patient we are looking for with diabetes is now doing another one of his GCSE exams.
1.47 So we give up on that idea and go to **PAU** to see if any patients have turned up. We can't get into the department as none of our access cards work.
We wait for someone to answer the entry-phone;
A nurse answers –*'hello can I help you?'* (it couldn't sound more unhelpful).
…. 'hi we're medical students' …'ok' (this is pretty inefficient?)
1.53 So we walk down the corridor to PAU and there is a Doctor there. The students hover awkwardly and he eventually looks up at them and understands;
*'I dont work here I'm the orthopaedic **SHO** you need to speak to her'*
(he points at the staff nurse who was at the desk but is now gone to the kitchen. The nurse returns and is busy with the computer system (this is the system that she showed me last week that shows all the patients that are in PAU) it seems a

shame that the students don't get to be taught about this, but I guess there isn't the time to show each student every week.

2.03 After a while she looks up, the students feel awkward about asking too many people, but one of them asks if they can see any of the patients. She looks awkward

Nurse: '*well this one has been seen by the 4th years ,and this one is non-weight bearing (has pains in his legs), so you can't examine him*'.

Now the students don't really know what to do;

2.04 The students take up a standing position behind the nurse and the SHO at the nursing station. This goes on for about 10 minutes with no-one really speaking. I feel the students could push themselves more, but sense that S is the main driver for negotiations. He is charismatic, good looking and confident - it must be hard for shy ones who don't look like models.

The students shuffle over and say they are going back to the ward.

2.25 The 2 remaining students now split up and I tag along with one of them. She has decided to see a patient with **bronchiolitis** and we walk to B ward. The patient has gone home though, and I can see that she is getting really annoyed: *'this is so frustrating'*

2.40 Now we just wander around the ward looking for patients, but there is no-one to see: '*If I don't find anyone I'm going home*'.

3.04 We pass the nursing station on the ward and an SHO says *'do you want to see a patient?' - I've got a few good patients you can see'*

The student is introduced to a patient and the parents and some visitors that are there beside the patient.

Using the assemblage method I Initially listed all possible network components under the label 'actor'.

For the exemplar vignette these could be:

Human actors: Students, Nurses, Junior Doctor, Patient, Visitor

Material actors: Access cards, entry codes, ward layout, computer system smartphones, wireless signal, architecture (nursing stations, PAU, ward layout)

I then considered some of the emerging properties – in this vignette, for the student actor these may be:

Action function: Students search and negotiate access for patients.

Semiotic functions: Students project friendly personas and pay attention to appearance.

Following this stage, I then considered potential relationship properties. As may be expected, the functions of students that were present on the wards tended to facilitate network relationships. However, material actors such as doors and door entry codes frequently exerted action functionality (barring students from entry through their physical presence) and so exerted inhibiting relationship properties. I tested these emerging interpretations through questioning of students in different situations and began to build a picture of how actor functions and relationship patterns varied, by using constant comparison. Through successive observation periods and subsequent iterative analyses, actor functions, relationships and network patterns could be compared to establish the emergent patterns and to what extent they were present across the observed data.

As observations and successive reading took place, so increasingly rich interpretation was added to the original observation notes. I took care to delineate between the interpretation and the original observations by using different coloured text (blue). A hermeneutic principle of close reading of text and then interpretation and use of theory built up a final set of field-notes that contained original observations, references to relevant papers, emerging thoughts (memos), highlighted potential vignettes and outline interpretation of some of these vignettes.

3.5.3.3 STAGE 2 - FORMAL ANALYSIS

Adapting ANT to the context of off-timetable learning in hospitals, took place in tandem with the observations. When I completed observations, a further period of development took place as a final conceptual framework was established. When this process had been completed, I now undertook formal analysis of all identified vignettes using the analytic concepts outlined in chapter two:

- **Actors** (human and material)
- **Functions** (action or semiotic)
- **Relations** (facilitating **+**, inhibiting **-**, ambiguous **+/-**, or intermediary **0**)
- **Learning processes** (observing, participating, mirroring, teaching, dissociating)

- **Network patterns** (change over time, stability)
- **Outcomes** (opportunities to learn skills, knowledge, clinical reasoning)

Using these descriptors, I was able to provide interpretations for most of the observed learning situations, though not all. ANT makes no claims that its analytic frameworks should necessarily explain all possible observed phenomena and therefore does not aim for totalising accounts (Fenwick, 2011, pp. 19-20). As outlined, ANT adopts a modest approach to its explanatory approach in line with poststructuralist thinking.

Using the descriptors, I now worked through vignettes, suggesting where possible how networks started, were maintained and then disintegrated. I then summarised the actors, functions and relationships in a summary diagram. An example of this summary relevant to the exemplar vignette is given in table 3.1:

Table 3.1 Exemplar vignette analytic summary table

Actor	Function	Relationship
Student	**Action** Locate and negotiate access to patients	**Facilitator**
	Semiotic Projecting competence	**Facilitator**
Junior doctor (1)	**Semiotic** Disinterested and unhelpful verbal and non-verbal cues	**Inhibitor**
Junior doctor (2)	**Action** Approaches students, locates and negotiates access to patient	**Facilitator**
Nurse	**Action** Allows entry, disallows patient access **Semiotic** Irritated verbal tones	**Ambiguous**
Patient		**Facilitator**
Visitor		**Intermediary**
Door / Access code	**Action** Bars access to wards	**Inhibitor**
Smartphone / wireless	**Action** Unable to be used – students disallowed network access	**Intermediary**
Computer / patient location software	**Action** Unable to be used – students disallowed access	**Intermediary**

Following this, I considered any emergent patterns that the network displayed such as stability, propensity to change and finally what contributions the network may make to developing technical proficiency – again using the terminology developed in chapter two.

In the case of the exemplar vignette, it may be possible to suggest that an emergent pattern concerns how much effort (action functionality) needs to be exerted by students in order to try to initiate networks and how long this process can take (here just over an hour and a half). I also suggest that at several times in the vignette, learning networks are on the point of forming but inhibiting

relationships caused by the action and semiotic functions of service network actors inhibit network formation and therefore opportunities to learn technical proficiency. Again, I checked these emerging interpretations at the observation site and through comparison with other vignettes. In this way, I built up a number of vignettes that exemplified commonly repeating associations of actors, functions and relationships – resulting in predictable processes, network patterns and outcomes.

I suggest that analysis of multiple vignettes may begin to outline some of the characteristics relevant to how clinical students learn technical proficiency.

3.6   THE INFLUENCE OF MY PROFESSIONAL ROLE ON THE STUDY DESIGN

Choice of research topic and study design

My role at the observation site involves school-wide responsibility for curriculum design, including clinical placements in both hospitals and general practices. As a GP and provider of clinical placements, I therefore have first-hand experience of general practice placements, but relatively little contemporary experience of hospital placements. Consequently, I was interested to learn more about this aspect of learning as it accounted for over 85% of the timetabled clinical learning time and a disproportionate amount of the clinical learning budget of approximately £25 Million (internal medical school documents). As outlined, my background and personal beliefs have led me to become involved in how to best deploy public resources. Learning more about how effective learning could take place in hospitals was a priority, as this is where the majority of time and resource are allocated. Personal observations led me to conclude that many hospital-based clinical providers 'filtered' or intellectualised student learning problems – partially because it was difficult for them as employees of the hospital to volunteer criticism due to the strong influence of management. I therefore concluded that as a partial outsider, I might be in a strategically useful position to make changes using empirical data. As a curriculum designer, I was interested to see if the study

findings could provide an impetus to improve the student learning experience by using the data to inform improvements to practice via end-user groups (in this case comprised of students, clinical teachers, managers, patients and curriculum designers). This approach has been pioneered in delivery of clinical care contexts by Engestrom, using an Activity Theory perspective (Engeström, 1993). However, several authors have drawn attention to the similarities between Activity Theory and ANT (Engeström, 2001; Karakus, 2013) and I was interested to see if the stakeholder group approach could be applied using ANT-derived data in a clinical learning context.

A focus on change was therefore an significant research objective and is reflected in research sub-question four outlined in chapter one. However, instigating large-scale change in a complex system at the same time as observing it brings potential methodological concerns. These concerns were offset mainly by the time delay between observations and instigation of change. Although observation, literature review and analysis proceeded in an iterative fashion, the implications of the findings and the resulting curriculum changes were not carried out until well after the observation period. For example, observations identified that curriculum learning outcomes were not being used in clinical learning. Accordingly all 54 learning outcomes for the week-long clinical placements in years three and four were changed and clinical placements were increased from one to three weeks where possible. However, these changes took place more than a year after the initial observations had taken place due to the slow nature of implementing programme-wide changes.

Paradoxically, dealing with more immediate, smaller-scale changes represented greater methodological challenges. For example, I frequently observed student difficulty in negotiating material and human actors such as security-coded doors and nurses blocking access to patients and it would have been possible in these circumstances to intervene. I resisted this, despite in many cases resultant network failure. At times, this was a cause of considerable frustration as I had invested considerable time in designing the clinical learning programme and it was difficult to observe how often learning networks failed to initiate.

My position as a clinician also influenced the focus on 'technical proficiency' as a significant part of the research question. As outlined, there is a considerable ethnographic literature outlining the development of medical student attitudes and identity that has been carried out by sociologists. However, there are no scholarly ethnographic accounts of how medical students develop technical competency. This may be because the majority of ethnographers are not medically trained - with the exception of Sinclair (Sinclair, 1997) - and so interpretation of diagnostic and clinical skills is more problematic as these sills are to a large extent dependant on a large amount of pre-existing medical knowledge. As a clinician educated in a highly rationalist and technical environment and as a clinical teacher operating within this setting, I therefore felt able to explore this aspect of learning and contribute to better understanding how medical students develop overall clinical competence. In addition, my autobiographical experience of the clinical environment suggested that my day-to-day practice was highly dependent on techno-material actors such as computers, access cards, software programmes and institutional regulations.

Choice and development of analytic perspective and methods

Initial focus groups and student evaluation highlighted broad issues concerning access to patients, student dissociation and the inhibitory effect of some summative assessments in student clinical learning. However, they did not indicate the relationships between these variables or the underlying processes in clinical learning that may better inform how learning may be improved. I therefore adopted an observational approach to data collection partially to provide information that may allow subsequent improvement to the student learning experience. Direct observation of student learning indicated many opportunities to improve student learning. Improving the learning experiences of clinical students was a stated aim of the research and I therefore sought a method of representing observations that might provide data that would facilitate this change process.

Early observations suggested that material considerations played a prominent part in student learning and I therefore sought an analytic framework that would interpret data in a way that might incorporate these material considerations.

Two main approaches appeared possible. Firstly the use of cultural historical activity theory (Engeström, 2014), that incorporated material considerations through the use of the analytic term 'artefacts'. However, I found the complex and pre-ordained nature of the overall analytic framework difficult to operationalize in the context of the rapidly changing clinical learning environment. This view is corroborated by Morris and others (Karakus, 2013; Morris, 2012a).

ANT appeared to offer more flexibility in developing an analytic framework that would reflect rapidly changing material and social considerations, as the studies appeared less prescriptive in the way in which analytic concepts could be applied. Indeed some influential ANT-type authors (Latour, 1996; Law and Hassard, 1999) appear to actively encourage development of ANT to the extent that many of the original ANT theorists appear to have distanced themselves from using the term ANT for fear that it may solidify the field and prevent innovative approaches. As such, some authors prefer the use of alternative terms such as material semiotics and science and technology studies. This more adaptable approach allowed the necessary flexibility to design an analytic framework capable of interpreting a field that appeared to have been insufficiently theorised and adapted for empirical use in rapidly changing situations such as clinical learning.

Initial reading of ANT studies highlighted the role of human and material actors and this simple analytic distinction appeared to suggest many avenues of potential improvement as student learning appeared significantly influenced by proficiency with techno-material actors. However, I could not locate the necessary analytic terminology within ANT studies to explain either how these actors were related or how those relations rapidly changed in the clinical learning environment.

In tandem with the development of an interpretive framework capable of producing results that might drive curriculum improvement, I also wanted to develop a framework that might be of practical use to curriculum planners. My job as a curriculum planner had sensitised me to the drawbacks of articulating highly

specific learning outcomes. Firstly, because of the time it took to classify and distribute clinical knowledge to this level of detail, and secondly because initial focus groups and data collection had highlighted that the outcomes and curriculum in its present form were seldom used. Material factors again accounted in part for this, but also the serendipitous presentation of clinical cases and the unpredictability of the learning environment.

Development of action and semiotic functions suggested a potential dual role in refining an interpretive framework and practical use in curriculum planning. For example, initial observations suggested students had to complete a number of action functions in order to initiate learning networks. Once identified, these naturally lent themselves to form part of a planning tool that might be of pragmatic use. Interpretation of both findings and literature was therefore informed by a dual purpose of developing a set of precision analytic tools that would also provide pragmatic ways of planning work-based learning.

My position of curriculum designer also influenced how vignettes typifying clinical learning were identified and extracted from field-notes. As outlined, it caused discomfort, embarrassment and considerable distress for me to observe students attempting over a number of hours to initiate learning networks that would usually end in failure. I felt this partially because I was responsible for curriculum planning and I had not envisaged students spending their time in this manner. However, this is the way in which I had spent the majority of my own clinical learning. It is possible that I had 'filtered' this negative experience from my own recollections. Realisation of this served to compound a sense of failure and a desire to improve learning. I also felt a sense of injustice that public money was being spent in this way. Clinical learning is disproportionately expensive compared to other undergraduate courses – costing on average in excess of £60,000 per year. I felt a sense of shame that money that I was responsible for was being used in this way. It is possible that these emotions contributed to vignettes representing network failure being highlighted.

At a more theoretical level, ANT encourages the analysis of 'problems' (Fenwick and Edwards, 2011) as an effective way in analysing how complex systems

operate. I have suggested that medicine in particular may 'filter' problems and negative outcome scenarios. Recent literature about how hospitals deal with patient deaths supports this argument (Francis, 2013). Analysis of network failure therefore forms a significant part of the analysis and rationale for selection of vignettes.

Process of change

Interpretation of vignettes using the analytic framework provided empirical evidence that was used to improve student learning. These improvements took place after the period of observation, however some of the changes were implemented during the course of writing up the study. As outlined the structural mechanism used to bring about change was a curriculum group that consisted of key actors from the clinical learning and service networks. The group had a degree of institutional power but involved a limited amount of senior medical school decision makers. To bring about change at senior level I used Kotter's model of change (Kotter, 1995) outlined below:

1. Raising a sense of urgency
2. Build a guiding team
3. Build a strong vision
4. Communicate the vision widely
5. Work actively to remove barriers to change
6. Create short-term visible changes
7. Don't give up

In order to apply this model effectively I searched for expertise in change management, attended relevant courses in educational leadership and received mentoring in delivering change. Due to finance constraints, my guiding team (see step 2) was disbanded during the course of the study. In addition, the medical school went through a series of drastic organisational and senior personnel changes, including splitting into three separate medical schools and a succession of four deans and four vice-deans. These changes had significant effects on the ability to deliver school-wide changes. Nevertheless, the adoption of a model of

change was useful in highlighting priorities in the change process and for re-establishing momentum when setbacks occurred. Study data was particularly effective in step 1 (raising a sense of urgency), as there was considerable inertia to the idea of curricular change. The dissolution of a guiding team was perhaps the most significant drawback and the majority of the change has been brought about individually, over long time-frames.

The combination of my deeply held ethical beliefs and my role as a curriculum developer at the observation site has therefore had significant influence over the development of the research question, study design, analysis and subsequent use of study data to improve student learning and curriculum design. This change aspect of the study was a significant part of the rationale for the study as outlined in research sub-question four, outlined in chapter one. The changes brought about through observation of student learning and subsequent network analysis are further discussed in chapter five.

3.7   SUMMARY

I negotiated access to a ward at a hospital and have carried out two years of observing student learning following a focussed ethnographic approach. By directing observations to Tuesdays, I have oriented data collection to give the maximal chance of observing off-timetable learning. Through this approach, many instances of successful and unsuccessful network formation have been observed thus giving ample opportunity for the data collected to answer the research question.

CHAPTER 4 – RESULTS

4.1 INTRODUCTION

This chapter presents the results and initial analysis relevant to the main research question: How do medical students learn technical proficiency in a modern hospital? – and the related sub-questions:

1. What do students do in order to learn technical proficiency?
2. How do they go about doing it?
3. What contribution does this make to learning technical proficiency?

The presentation of data follows the structure of the sub-questions. Firstly, vignettes are presented that exemplify frequently observed learning events that outline in detail what students do to learn technical proficiency. Secondly, the ANT framework is used to analyse these vignettes, providing detailed analysis of how learning opportunities are generated. This analysis focusses on how actors, functions and relationships interact to produce learning networks that are initiated, maintained and finally disintegrate. Functioning learning networks are further analysed by identifying the different types of learning processes within them. In each vignette, emphasis is given to one learning process in order to provide a more detailed level of analysis.

Finally, the contribution of the vignettes, towards technical proficiency is assessed. A summary of the vignettes is outlined in table 4.1:

Table 4.1 Summary of vignettes

	Vignette	Actor-Network analysis
1	**The storeroom** Students locate a patient and receive teaching in a storeroom cupboard	Network initiated - Fragile and unstable - **Mirroring** emphasis **Relevant actors and relationships** • Mirroring = Student + Patient actors • Initiation via student action functions and semiotic acknowledgement • Human service network inhibitors via semiotic and action functions • Curriculum actor as intermediary **Network outcomes – learning opportunities** • Communication skills, diagnostic skills, clinical reasoning • Difficulty of knowledge recall • Technical skills not observed
2	**Perfect 5th year** Students clerk a patient, but are interrupted by a ward round and then watch a 5th year student	Network initiated - Several initiation steps - **Mirroring** emphasis **Relevant actors and relationships** • Mirroring = Student + Patient actor • Initiation via student action functions and semiotic acknowledgement • Material inhibitors (including curriculum) • Students appear dislocated **Network outcomes – learning opportunities** • Communication skills, diagnostic skills, clinical reasoning • Difficulty of knowledge recall • Technical skills not observed
3	**Moveable feast** Students attempt to initiate networks in multiple locations: A+E, the ward, day case unit and back on the ward. They are successful twice	Two networks initiated – Multiple processes – **Participatory** emphasis **Relevant actors and relationships** • Participation = Doctor + Student + Patient • Clinical learning cycles demonstrated – initiation, maintenance, disintegration • Semiotic filtering demonstrated by teacher actor • Semiotic effect of scare stories / negative outcome events **Network outcomes – learning opportunities** • Students apply general knowledge to specific patients • Examination skills observed
4	**Perfect 3rd year** A student participates in a case discussion	Network initiated – One learning process - **Participatory** **Relevant actors and relationships** • Participation = Doctor + Student + Patient related material • Longer placements generate stronger relations between actors • Techno-material nature of clinician communication • Student facilitating semiotic functions **Network outcomes – learning opportunities** • Students apply general knowledge to specific patients • Technical skills not observed
5	**Handover** Students observe a handover of patients	Partial network formation - **Observational** learning process **Relevant actors and relationships** • Student, Service network provider, Patient/patient material actors present. Partial / weak relationships. • Technical nature of network semiotic communication

		Network outcomes – learning opportunities
		• Student presence not acknowledged – knowledge acquisition behaviours not observed / minimal • Technical skills not observed
6	**Bright blue shoes** Student action functions to initiate a learning network fail due to material inhibitors and lack of semiotic acceptance.	**Network initiation failure** **Relevant actors and relationships** • Student semiotic functions not reciprocated / accepted • Nurse ambiguous relationship • Material inhibitors, including technical patient care apparatus exerting semiotic functions • Students have low power status **Outcomes** • Few observable outcomes relating to clinical proficiency • Student leaves clinical environment
7	**Where is the doctor?** Students initially search for their teacher and then try unsuccessfully to initiate other learning networks	**Network initiation failure** **Relevant actors and relationships** • Students exert considerable action function • Material inhibitors and intermediaries; short placements may exacerbate this • Students appear dislocated and have little power **Outcomes** • Few observable outcomes relating to clinical proficiency • Student leaves clinical environment
8	**'F'** A student dissociates from the learning environment	**Student disassociation from clinical learning** **Relevant actors and relationships** • Assessment and curriculum actors as inhibitors • Student semiotic functions not reciprocated / accepted • Semiotic function of humiliating apocryphal tales **Outcomes** • Student stays at home and does not attend placements • Student learns general medical knowledge in order to pass knowledge-based exams.

4.2 CONTEXT OF VIGNETTES

I observed a formal teaching session and introductory ward round in the morning in order to familiarise the students to my presence. Although not the focus of this study, this time also served to triangulate many of the observations of off-timetable learning that took place later in the day.

The formal teaching would end mid-way through the morning and the timetable stated that the rest of the day was spent learning 'off-timetable' from patients. This time forms a focus of the study. For orientation purposes, the following extract

from observation notes, gives an outline of the first part of the day, before off-timetable learning:

'Students arrive at the entrance to the ward after gaining entrance to the hospital and walking its long corridors:

Figure 4.1 Photograph of Hospital corridor.

Access to the ward is via smartcard which the students did not have activated. Students would press a buzzer and wait for entry. Once inside, students looked for the common room, where the night team of junior doctors and consultants would hand-over patients admitted overnight, to a different day team. The patients on the ward were summarised on a sheet of A4, which was sometimes given to the students. The handover took place in an unmarked room on the ward and I often

spotted students in other parts of the ward, looking for this room. The room had a combination lock but students were not issued with the code. Students would therefore usually arrive late and would have to knock on the door and be let in. This caused continual disruption to the handover process and was uncomfortable for the students. After half an hour or so, a new consultant would arrive and ask if there were any third-year students. These students (and myself) would now leave the hand-over to start an introductory ward round, but students were often unsure what would be needed and often elected to leave their belongings in the hand-over room. By 9am therefore, students have negotiated doors, ward layout, door access codes, handover and now the arrival of a new clinical teacher (consultant). The consultant now takes students on a tour of the ward and introduces students to the ward and the curriculum for the week. Students commented that a tour did not take place on other attachments. The ward-based curriculum delivered by the clinical teachers (dehydration and how to examine a child) was different to the medical school curriculum (diabetes). Diabetes cases were very rarely present on the ward and this made the medical school curriculum somewhat redundant. Consequently, the department had devised a separate curriculum that better reflected the experiences that could be offered to the students. Each consultant delivered this curriculum with a different emphasis, and invariably it was written on a piece of paper. This bespoke curriculum was then given to one of the two or three students present. Following this, students were encouraged to apply this teaching to real cases by 'clerking' (speaking to) real patients. The majority of their time was spent trying to bring about the conditions to make this possible.

In the first vignette, the students have been successful and a learning network is initiated. Networks commonly contained several learning processes. To enable detailed analysis of these, each of the following vignettes provides analysis of the learning network, but gives emphasis to a single learning process. To enable comparison, some processes are highlighted in more than one vignette. For example, vignettes one and two describe networks containing several processes, but give emphasis to the mirroring learning process.

VIGNETTES AND ANALYSIS

4.3   MIRRORING LEARNING PROCESSES

4.3.1   VIGNETTE 1 – STORE-ROOM CUPBOARD

In this vignette, a group of three students are wandering around the A&E department in search of patients. They spend most of the time waiting at nursing stations and trying not to get in the way. They have had several attempts at network initiation since the end of the introductory ward round three hours previously, but these have been unsuccessful. A junior doctor (SHO), who the students do not know, now takes the initiative.

2.15 The students are sent by the **SHO** to see a patient who has come to **A+E** and is waiting for the consultant to review. It's very busy, with other students, nurses, doctors, patients, porters and cleaners all moving about and talking. The students pause outside the room and look in - they pause again – they look very uncomfortable. They edge in – this would not win my confidence – *'er..I'm a third year medical student……'* the parents although worried about their dehydrated child manage somehow to make an effort to make the students feel at home – it's a bit sad to compare this with the way student nurses confidently enter the room to take **obs**.
It's difficult for me to hear much– the 'Lion King' is on again and it's an upbeat trad jazz number…'Oh I just can't wait to be king'
So there is mum, dad, 2 students, me and a **paramedic** student from Plymouth. The mum starts talking and the students ask the clerking questions
What is the presenting complaint? What is the past medical history?
2.19 A nurse comes in and takes some obs and the toddler is hot - *'you need to take all his clothes off'* and she goes. The child looks upset and mum asks dad to fetch some currents and biscuits from the pram. The undressing duly occurs
2.23 The student asks a few more clerking questions and checks back on the sheet that the consultant gave her at the intro session. Many of these questions now concern the situation at home and mum is evidently taken aback at the implications of parental ineptitude and low social class - and so the conversation begins to dry up. I'm not sure if the students appreciate why.
2.25 Then another consultant arrives; *'OK It's a case of **D and V** and dehydration so this is a good case for you'*
She knows the department curriculum
'Lets go, and you can present (the case) to me'

2.30 After wandering round for 5 minutes we find some quiet space – it's a large store cupboard, lined from floor to ceiling with shelves holding technical equipment – there are **endotracheal tubes**, syringes and **cuffs**, fluids and dressings.
I wonder how many students have used this as a learning resource. There are 4 of us – it's tiny - about 3x3 metres and a nurse is in about every minute or so.
This consultant is different;   As well as the usual Q and A about book-reading it's:
What do you think is going on?
The students struggle once again to reproduce the knowledge here. Now she explains what she is thinking.
'What would you do?'
This is real knowledge creation for the medical students as opposed to them repeating what they already know – knowledge reproduction
2.35   The friendly SHO interrupts and asks for advice.
2.39   Nurse comes and opens up the drug cupboard.
2.40   Doing causes of vomiting, back to Q and A and applied physiology
2.43   SHO back again
2.45   Consultant gives feedback to student *'that's not bad'*
Student; '*can I examine him (the baby)?'*
Consultant*; 'hmm I'm not sure that will be the third time; let me examine him first'*
(baby has been examined by GP, SHO and now consultant)
2.50   The consultant tries to examine but the child is fried and starts crying – it's too much and the consultant sends the baby home.

4.3.1.1 VIGNETTE 1 ANALYSIS

1)   NETWORK INITIATION

The friendly SHO exerts semiotic function through acknowledging student presence. Learning networks were often initiated in this way. Often students would wait on wards for considerable amounts of time without this acknowledgement (as demonstrated in the exemplar vignette). The SHO also exerts action functions by locating a suitable patient and allowing access to the patient. These functions allow the students to initiate a learning network through forming facilitating relationships with a knowledge source actor; their previous attempts having been unsuccessful. For students, locating and then negotiating access to suitable patients was a considerable hurdle. In this vignette, students are dependent on junior doctors and nurses to locate patients. No system existed that alerted students when suitable patients arrived at A+E and so students either

waited for suitable patients, or went to the library and called back in on the ward on the off-chance that patients would be present.

A negotiation now takes place between the students and the patient. Patients rarely refused access, but as this vignette illustrates, would often curtail or stop interviews that they perceived as intrusive.

The semiotic functions of students often played significant roles in network initiation. In the vignette, junior students enter the room gradually, wait for acknowledgement from the parents and speak softly and hesitantly. This contrasts significantly with the semiotic functions projected by the nurses. Service network actors such as nurses commonly utilised a complex mix of semiotic functions in their dealings with patients that I term 'projected competence'. In the vignette, this includes entering briskly and adopting a speech pattern that assumes patient compliance. Junior students often attempted to reproduce these characteristics. However, in contrast to the diminished projections of competence demonstrated in this vignette, many students would exaggerate projections of competence and this is demonstrated in vignette 6.

Despite the inhibiting effects of interruptions, a number of facilitating relationships are established between student, the SHO and the patient and this allows a network to be established.

2) NETWORK MAINTENANCE

A learning network now arises, where student actors form facilitating relationships with the patient actor.

Students spend the majority of this time asking the patient a set of questions that mirrors the practice of admitting acutely ill patients. The structure of these questions (the clerking procedure), is based around the diagnostic model of clinical reasoning outlined in chapter 1 and is articulated in most standard clinical textbooks (Hope *et al*, 1989, p. 20). The questions are:

PC - Presenting complaint – What major symptoms is the patient experiencing?

HOPC – History of the presenting complaint – What has happened recently to bring the patient into hospital?

PMH – Past medical history

DH / SH – Drug and social history

O/E – On Examination

Dx or DD – Diagnosis or Differential diagnosis

MT – Management (or treatment) plan

The clerking procedure used by junior doctor actors assumes prior clinical experience and does not interrogate the more fundamental aspects of medical conditions such as how various complaints first started or how conditions have developed over time. During observations, junior students consistently used the clerking procedure and did not vary this method of questioning to interrogate more fundamental aspects of patient's conditions.

Opportunities to increase clinical knowledge appeared limited therefore by the student action function of asking questions that followed a tightly defined procedure relating to establishing a diagnosis.

Students would usually perform and log two successful clerking mirroring practices per week in order to fulfil the mandatory requirements of the school (internal assessment documents). However, as this vignette demonstrates, initiating a network in order to fulfil this process would often take many hours.

Through the clerking activity, students therefore mimic or mirror, work-related activity but their findings were never entered into the patient notes. Occasionally, some clinical information was relayed to work providers orally.

The arrival of a service network actor (consultant) to review the patient now interrupts the student before the clerking procedure is complete. The mirroring process now ceases and a teaching process begins. The consultant exerts action functions in removing the students to a quieter place (a storeroom) where clinical teaching can take place. The clinical learning network now shifts from using the patient as the sole knowledge-source actor, to the consultant as an additional knowledge-source actor.

The student now presents the information obtained from the clerking procedure to the consultant in the manner of a junior doctor. This information may or may not be subsequently used in decisions regarding patient care. It is possible to claim therefore that the student gains the opportunity to participate indirectly in the work of the service network.

In addition, the consultant quizzes the students on applied physiology, potential diagnoses and management plans. The students appear to have difficulty recalling knowledge in this context and both the questions and attempted answers are interrupted by action functions of service network actors.

Action functions of service provider actors (Nurses and SHOs) continually inhibit relationships within the nascent learning network; initially through taking observations and latterly by entering the storeroom to retrieve medical items and question the teacher actor about patient-related matters. The learning network is also frequently interrupted by the semiotic projections of material service network actors such as bleeps, alarms, and film soundtracks.

After approximately ten minutes, the teaching process ceases and the student and teacher learning-source actors move location, again, to try and establish a new learning process with the patient actor. Despite asking to examine the patient, the students are denied access by action functions of the patient's mother (refusal). Guided participation models of learning (Dornan *et al*, 2007) imply that three actors are present in clinical learning situations: patient, student and teacher. However, I did not observe this combination of actors in mirroring processes taking place in off-timetable learning. I suggest that the fundamental actor relationship in mirroring learning processes consists of facilitating relationships between student and patient knowledge-source actor. This process appears to mirror but not contribute to the work of the clinical team.

3)   NETWORK DISINTEGRATION

The various student and knowledge-source actor relationships that define this particular learning network disintegrate finally when the consultant actor exhibits action functions by re-joining the service network.

Further student action functions (negotiation with a nurse for access to a patient knowledge-source actor) are refused, on grounds of nothing suitable being available. The network disintegrates as the students leave the department to do library work. Students do not appear comfortable waiting in the department for suitable patients to become available and do not engage in work activities whilst waiting for other learning opportunities.

4)   NETWORK OUTCOMES – LEARNING OPPORTUNITIES FOR TECHNICAL PROFICIENCY

The mirroring process produces outcomes that create opportunities to learn communication skills. In this case, difficult areas relating to social class and parenting skills are interrogated by novices. Parents often indicated that they found these questions excessively prying, given the status of the student. Students either did not appear to notice or ignored these cues.

The mirroring process also helps students to build up case knowedge (here, viral gastro-enteritis resulting in dehydration). As previously discussed, clinicians may draw on this case knowledge when formulating diagnoses, through recognising the repeating patterns seen in previous cases.

The presence of a teacher actor dramatically changes possible learning opportunities and creates a teaching process. Now feedback on performance is possible and the students receive teaching. Students are coached in presentation style, diagnostic reasoning and how to apply this to a specific case. Although rarely observed, this case-specific teaching from experienced consultants generated multiple learning opportunities. Dornan's model of clinical learning (Dornan *et al*, 2007) does not identify teaching processes and I suggest that this forms a part of off-timetable learning.

Table 4.2 Summary of Actors, functions and relationships for vignette 1

Actor	Function	Relationship
Student	**Action functions** Presence on ward, attempt to locate patients **Semiotic functions** Hesitant and awkward	**Facilitating** **Inhibiting**
SHO 1	**Action functions** Locates and negotiates access to patient actor	**Facilitating**
SHO 2	**Action functions** Interrupts learning network in store-room to ask questions	**Inhibiting**
Teacher	**Action functions** Teaching techniques, removes students to avoid service network	**Facilitating**
Patient	**Semiotic functions** Allows students to ask questions. Subsequently closes down intrusive questions.	**Facilitating**
Nurse	**Action functions** Needs of patient care, suggesting all other patients are unsuitable	**Inhibiting**
Knowledge object (curriculum)	**Action functions** Inoperative due to lack of index case material (diabetes) on the ward	**Intermediary**
Instrument (television)	**Semiotic function** Noise inhibits learning	**Inhibitor**

Figure 4.2 Summary of Network development for vignette 1

When networks disintegrated or failed to initiate in one clinical learning environment, students frequently tried to initiate a learning network elsewhere. In the next vignette, students exert action functions by leaving A+E and returning to the ward to initiate another network.

4.3.2 VIGNETTE 2 – PERFECT 5TH YEAR

This vignette has been selected to outline the stages involved in network initiation and to reinforce the unstable, fluid nature of learning networks once they are initiated. The vignette also focusses on mirroring practices in order to draw comparison with the preceding vignette.

10.03 – After the ward round finishes, the consultant wants to talk to me and the students loiter and chat in the corridor. I'm slightly annoyed at missing their conversation. I go back to the doctors common room to find them. The students tell me about the corridor conversation that I missed; *'We were deciding what to do next.'*
They can't remember what the consultant has said. One of them begins to tell me about when to see patients: *'The mornings are best because then there is lunch, then there is rest period and visiting and then they are tired or have already been seen.'*
Now they look at the computer, to try and find patients but can't work it out (they don't have the right passwords)
'What are the different ward areas again?' (they can't remember which part of the ward the patients are on – the consultant told them this on the ward round)
'Let's ask the nurses' We do and are directed to another part of the ward
We go to Bramble Green
Nurse: *'They (the patients) should all be ok, but we haven't had the ward round yet.'* Her verbal and non-verbal approach is decidedly dispiriting.
10.35 - The students stop. One now goes off on her own to clerk a patient. But two are left and are kind of aimless – why? They are quite shy and pause.

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Again this is really awkward – the students kind of just stand there – and so do I.
10.44 - Eventually a friendly looking new nurse comes onto the ward and the students ask the same questions again '*Are there any patients to see?'*
She is so kind to them and the students smile for the first time – I can see that the whole process for them must be very stressful
10.45 - The students emboldened go and ask the parents;
'*Hi we are 3rd year medical students – do you mind if we talk to you for a while?'* - everything is fine.
10.47 - They start by asking questions about what sort of symptoms the baby had initially. In this case the diagnosis is a well-established ventriculo-septal defect (a hole in the heart) but the symptoms keep recurring (the baby becomes out of breath) – necessitating admission to hospital. As the story progresses, it becomes clear that there are social and psychological issues. Once off the physical stuff though, the questions come across as insensitive – the parents begin to evade, and the information they offer is overlooked by the students anyway.
10.50 - The ward round – DR2 comes along and interrupts the student. There is a brief question and answer session for the students
Most of the q's are about applied physiology and why / how things work. They are very good questions but the students don't seem to know the answers again.
A 5th year is with DR2 – there could not be a bigger difference – she is busy, engaged. Has the notes (the notes symbolise so much here), she has the **obs sheets** as well. The nurses ? don't look too keen on this,. She has the **patient location sheet** (the 3rd years don't) that is tucked into her bleep, she writes in the notes, although asks DR2 to check what she has written.
The students stop talking to the patient and join the ward round – back at the nursing station DR2 asks the 5th year to look up a result on the computer, but the 5th year student does not have access to the computer results system
10.56
DR2: '*What, are you a medical student?'*
Shortly after the students reluctantly leave to go to a compulsory lunchtime lecture.

4.3.2.1 VIGNETTE 2 ANALYSIS

1)   NETWORK INITIATION

Similarities begin to emerge with vignette 1. Again, the student actors utilise action functions to locate a suitable patient knowledge source actor. These include planning in the corridor, locating patients by interrogating (unsuccessfully) the computers and asking nurses. Again, there are material inhibitors such as the disorienting ward layout. There are also material actors that are present but are not utilised (intermediaries). These include material instruments such as pens and notebooks left in the junior doctor office, as students did not have time to retrieve

them at the beginning of the ward round and had nowhere to put them. In contrast to Sinclair's observations (Sinclair, 1997), students are no longer required to wear white coats and this results in a problem concerning the action function of where to put simple material learning instruments such as books, pens, notebooks and equipment necessary for patient examinations. Curriculum documents at the observation site did not appear to cover these material considerations (internal curriculum documents).

Computers appear to exert intermediary relationships in this vignette with the students. Whilst ubiquitous and essential for service network actors to locate patient information, they could not form relationships with student actors, as the students were not issued with the necessary passwords.

Once a suitable patient is located, a negotiation with gatekeeper actor (again a nurse) ensues and the first nurse appears to establish ambiguous relationships with the student actor - at once encouraging student access to patients but accurately warning that it may be interrupted. This seems to result in student discomfort and they now appear to wait for semiotic acknowledgement of their presence. This eventually happens through semiotic functions of another nurse. The students appear relieved and additional action functions are extended by the friendly nurse through negotiating patient access. The process of planning, locating and negotiation appears stressful for the students, possibly as a result of having to exert considerable effort in unconventional social circumstances.

The initiation stages in both vignettes appear to include the following stages:

1. Planning
2. Locating (patients or other knowledge sources)
3. Waiting for acknowledgement of presence at site of knowledge source (patient actor)
4. Negotiating access to knowledge source.

2) NETWORK MAINTENANCE

The learning network initially contains a mirroring learning process that again involves a clerking procedure that uses the same set of questions. As discussed, these questions focus on establishing a diagnosis; however, in this case the diagnosis is well established. After five minutes the clerking procedure is interrupted by the service network (ward round) and the students are now asked questions concerning the anatomy and physiology of the infant heart. Again, in this busy environment, students seem unable to retrieve information to answer the questions. The student–doctor interaction produces a teaching process. This rapidly disintegrates and the students now join the fifth year and doctor on a ward round (observation learning process).

The fifth-year student is carrying out a participative learning process (writing in the notes), however the consultant has assumed she is a junior doctor. This suggests a somewhat impersonal nature of clinical learning, resulting from students and doctors not knowing each other. In both vignettes, the students appear dislocated. They do not know the layout of the ward or the names of the nurses or doctors. They do not have access passwords to the computers and don't know where to leave their personal belongings. Lack of facility with service network material actors appears to produce inhibiting relationships regarding network initiation and vignette 4 (perfect 3rd year) illustrates that this lack of facility may be related to the time that students spend in a particular environment.

The two vignettes also begin to suggest certain relationships between student and curriculum actors. In vignette 1 the curriculum content specifies diabetes as an index case to guide learning during the attachment. However, I observed only one patient with this condition during the study (patient in exemplar vignette). In this case, highly specified curriculum content appears counterproductive, as it cannot be adapted to the varying clinical caseload.

3) NETWORK DISINTEGRATION

The learning network disintegrates after a relatively short time – this time because of the timetable actor. The students sever emerging relationships with service

network actors because of an upcoming lunchtime lecture and disengage from the clinical learning network.

The relationship between the medical school timetable outlined in chapter 1 and the service network (hospital) timetable outlined by the student in the vignette seem contradictory. Comparing the hospital timetable to the medical school timetable shows that for much of the self-directed learning time advocated by the medical school (during which students are assumed to be learning from patients), the patients are unavailable. Mealtimes, resting periods and visiting periods all appeared to take priority over student learning and took place at the same time as the proposed time for learning from patients. When additional service action functions such as ward rounds, patient treatments and patient investigations are also considered, location of patients can appear problematic.

4) NETWORK OUTCOMES – LEARNING OPPORTUNITIES FOR TECHNICAL PROFICIENCY

Outcomes of the brief network are considerable. The student practises communication techniques, information gathering and processing concerning the diagnosis. The student also adds to case knowledge of paediatric cardiac problems. Through encouragement from teachers and use of open questions, the student also touches on more psychological and social issues. Analysis of curriculum documents at the observation site suggests that students are not systematically taught psychology or sociology and do not learn corresponding psychological or sociological 'clerking' skills. In vignette one, I suggested that as a result of the clerking method of questioning, students may not ask about the more basic physical aspects of conditions. In this vignette, it also appears that the ubiquitous use of the clerking method without appropriate additional skills may also reduce student learning about the social and psychological aspects of medical conditions.

In this particular environment, the student is unable to recall knowledge learned in previous years during the teaching process. As discussed, interference from service network actors frequently appears to make this problematic. The student

actors again, do not perform clinical examinations or carry out clinical procedures on the patient.

Table 4.3 Summary of Actors, Functions and relationships for vignette 2

Actor	Function	Relationship
Principal actor: 3rd year student	**Action** Locates and negotiates patient access and maintains network	**Facilitating**
Other student actor 5th year student	**Action** Participates in ward round	**Inhibiting**
Knowledge source Patient	**Semiotic** Agrees to interview	**Facilitating**
Consultant 1	**Semiotic** Tells students where suitable patients are	**Facilitating**
Consultant 2	**Action** Interrupts student clerking	**Inhibiting**
Service network Friendly nurse	**Action** Locates patient **Semiotic** Acknowledges student presence	**Facilitating**
Other nurse	**Semiotic** Implies impending network interruption Subsequently does acknowledge student presence	**Ambiguous**
Material (Object of knowledge) Computer	**Semiotic** Information about patient location	**Intermediary** Students unable to access computer
Material (Object of knowledge) Curriculum timetable	**Action** Inaccurately suggests optimum time for learning process (clerking / mirroring). Lunchtime lecture removes student from nascent network.	**Inhibitor**

Figure 4.3 Summary of Network development for vignette 2
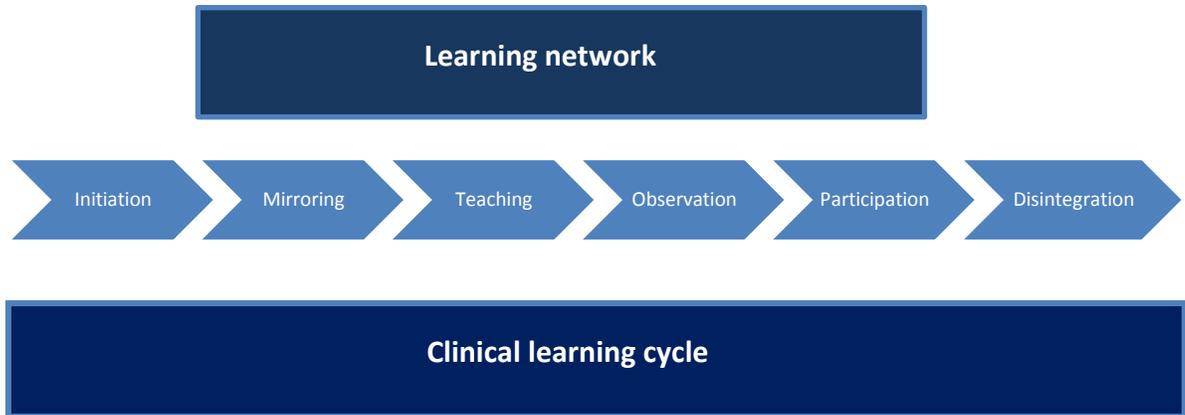
4.3.3 SUMMARY OF MIRRORING LEARNING PROCESS

Table 4.4. Summary of mirroring learning process

Characteristics	Infrequent, short-lived (minutes), prone to interruptions
Examples	Students clerk patients
Actor pattern	Student + Patient
Suggested outcomes	Communication skills Practical skills not observed Diagnostic skills occasionally observed

As outlined, the disintegration of each learning network was followed by the student action function of planning the next learning network. The most common result of this was for students to decide to leave the clinical environment for more stable networks at home or in the library. In contrast to the short, fluid networks previously described, students would remain part of these networks for many hours. Although this would take part during SDL or 'off-timetable' learning periods, these learning locations lie outside the confines of the clinical operating environment which is the focus of this study. Observations at these locations have

therefore been omitted. The characteristics of this learning may be a useful topic of further research.

4.4   PARTICIPATORY LEARNING PROCESSES

Sustained student participation in delivering work was not observed in this study. In contrast to the sustained immersion in work reported by Becker (Becker *et al*, 1961, p. 314), my observations found intermittent, short-lived associations containing various learning processes that sometimes included participatory processes. In the next vignette, students have been trying unsuccessfully to initiate a network for 90 minutes through exerting action functions such as locating and negotiating access to patients. Again, a sympathetic SHO (who the students do not know) helps initiate a short-lived, highly changeable network.

4.4.1   VIGNETTE 3 – MOVEABLE FEAST

This vignette demonstrates two learning networks and re-emphasises how multiple learning processes occur within each. Analysis now focusses on brief participatory learning processes, although for third years, these were rarely observed.

10.51 So they (the students) go straight to A&E and straight to the computer to look up any suitable patients. But the computer is off and does not start, so they go over to the nursing station. Zac, an SHO takes them under his wing and sends them to see 2 patients - but both have gone to X ray. Finally, a child with a head injury is found who has not been seen by the doctors.

11.15 They perform the usual clerking questions but they look quite green when it comes to taking off a simple bandage and they hesitate. They would really benefit from spending some time with either a junior or nurse getting their hands dirty on these things. Eventually the mum helps them out and takes off the bandage / dressing. I can see what they are thinking; *where are the ward bandages / dressings to put all of this back on?* So they leave without examining the baby and go to present their case to the SHO (Zac).

Zac listens to the case and they get some impromptu teaching;

Zac: '*Right if the baby has been knocked out they like to keep them in - sometimes for 4 hrs and sometimes for 6 hrs - it all depends on the consultant.*

Did you examine? Did you look in the ears for **CSF** *or blood? Now,* **boggy swelling***, what does that mean?*

Now what else do you need to ask? (They forgot to ask about vomiting)

Zac takes the studes back to see the patient - more teaching, the cut doesn't need stitching, then they all go back to consultant, present the case and the consultant gives the ok for discharge back home.

11.32 No more patients available to be seen according to the nurses, so back to Bramble ward

They try to join the ward round and are almost too persistent, the juniors have a hard time shaking these two off – they are polite but persistent and Jemma is very quick on her feet verbally:

'We can stay in the background'

'Do you need any help?'

But no go. The juniors say '*day case ward can be interesting'*

11.38 So we go there, but there are no patients

11.43 So they go back to the Doctor's common room and manage to spill tea over one of the junior's bags – there are 20 bags and loads of cups in this room, so I guess it's inevitable.

11.45 Some of the Drs are coming back for a post ward round discussion. It really is very pleasant, and nothing like I remember it. Everyone is very civil and they appear quite relaxed. There is more fresh coffee and the students chat with the juniors and get some more informal teaching.

12.15 Now Davie (a senior trainee) starts telling stories. The junior says *'Davie what was that case you were going to tell me about - the head circumferences'*

Davie tells a story about a baby brought in at 8weeks of age with increasing head circumference and was seen by him and then by the consultant in clinics - before being brought in again **fitting** due to being repeatedly shaken by the father - the baby is now **quadriplegic.**

This is a story told with feeling – there is no humour – and it punctures the bonhomie.

There is silence as the enormity of what he is saying sinks in to juniors and medical students. This isn't the world that is usually presented to them; the pain and suffering are normally glossed over, but right now some realities of medical practice are centre stage and it's very uncomfortable.

1) NETWORK INITIATION

The students try through various action functions for ninety minutes to initiate a network but are unsuccessful. The vignette begins with an object of knowledge (computer containing patient locations) again acting as an intermediary in network formation. Eventually, an SHO, who the students do not know, extends semiotic acknowledgement of student presence and then exerts action functions in locating

a patient who is waiting to be seen. This is done through goodwill and takes three attempts.

2)   NETWORK MAINTENANCE

Students instigate a mirroring learning process by forming facilitating relationships with the patient actor (clerking). However, lack of technical skills and not knowing the location of relevant material instruments (bandages and dressings) results in an excess of inhibiting relationships between student and these material actors and the mirroring process disintegrates prematurely. They present their findings to the SHO who subsequently presents this information to the consultant along with the students. In this way, students form a participatory learning process - participating in work and management decisions.

In contrast to mirroring processes involving student and patient actors, participatory processes occur when there are facilitating relationships between teacher, student and patient actors.

The SHO now exerts action functions, taking the students back to the patient and initiating a teaching process that follows a question and answer format about clinical knowledge.

The learning network now disintegrates as the junior doctor leaves to perform clinical work and is therefore unable to exert further action functions in locating patients for the students. Students now exert action functions and negotiate with nurses but are told that no further patients are available in A&E. Through exerting more action functions (again, planning and locating patients), students now return to the ward, exert (unsuccessful) action functions in negotiating access to a ward round and further (unsuccessful) action functions in locating patients on the day-case ward.

They finally initiate a brief network involving an observational process. Here, students listen to a tale being told by a senior trainee but with little acknowledgement of their presence. As outlined in previous vignettes, students often waited for semiotic acknowledgement of their presence but often this was not forthcoming. I defined this as 'filtering'; where human or material actors are not

acknowledged by service network actors. I suggest that this may be necessary for service delivery actors in order to get work done in an environment with many interruptions and distractions. Filtering was commonly observed and could sometimes appear pronounced as the following vignette fragment suggests (see fig 5.3 for a photograph of this location).

10.35 We are sat at the red spotty table once again for some informal teaching (see photograph in figure 5.3).
Horrible crying, **sat monitor** is off and beeping, laundry delivered…
DR: '…and 90% of children will have reached this **developmental milestone** by now.' Whilst this is going on, I take a look around – a nurse is visiting the ward manager, children and staff are in and out of the ward school, nurses get water from fountain that is adjacent to the table.
10.42 Crying stops
ST *'I was thinking how long that could go on for?'*
DR *'was there crying?'*
ST Hand to her mouth
DR *'I was zoned in – it didn't sound a worrying cry'*
This is shocking – but there is no time to take this in, we go on with more childhood development
10.45 Baby crying again
10.50 Baby still crying, we are now onto some basic chemistry.
The students really struggle to do basic calculations (contrast this with the questions ST answers in the lecture at 12) – there must be something going on
They can't remember what the formula for salt is…really?

In this vignette fragment, the teacher actor filters out the semiotic projections of monitors and crying, to the extent that student actors project semiotic signals indicating shock. The students appear to lack this ability, and this appears to significantly affect their ability to recall basic knowledge. I suggest that in order to get work done, senior clinicians learn to filter out non-urgent interruptions such as alarms, voices and even some forms of crying. The implications of this are discussed in a later section.

3)   NETWORK DISINTEGRATION

The first learning network contains three learning processes involving different actors but students remain engaged with different knowledge source actors

(patient, junior doctor and senior doctor). However, the network disintegrates because of a lack of more patient actors in the A+E department.

The second learning network is terminated by the official timetable - in this case a lunchtime lecture that was compulsory. Here, a material actor (the student timetable) forms inhibiting relationships with the student actor in the context of clinical learning networks.

4) NETWORK OUTCOMES – LEARNING OPPORTUNITIES FOR TECHNICAL PROFICIENCY

Participative practices appeared to afford dense learning opportunities. Students practise communication and diagnostic skills through clerking a patient that has not been previously seen and where the diagnosis is uncertain. However, in a similar manner to vignettes 1 and 2, the students are not guided or observed in carrying out the clerking questions. Through presenting the case and possible diagnoses, the students contribute to the work of the clinical team. Students are given feedback from a junior doctor on the quality of their presentations and diagnostic reasoning. Subsequently, they are taken back to the patient to confirm their tentative diagnosis. Finally, the students and junior doctor return and present to the consultant who confirms both the diagnosis and management plan.   Through this primarily work-oriented process, students receive a more informal case-based teaching regarding examination and management of patients with head injury. This type of practically oriented, teaching delivered by junior doctors in the process of delivering care to patients, contrasts with more knowledge-based teaching received from senior teachers outlined in vignettes 1 and 2. However, I rarely observed this more informal type of teaching from junior doctors because participative processes occurred infrequently during observations.

A new learning network is initiated on the ward and students observe a negative-outcome case being told by an experienced trainee. Here, students are able to learn the natural course of clinical events and add to their store of scripts or prototypes. Negative outcome stories may play a part in developing clinical reasoning, but are seldom encountered in clinical textbooks or guidelines, where

diagnostic reasoning is often presented as a series of logical steps leading to positive identification of a diagnosis. I suggest from autobiographical experience that in practice, clinical reasoning is often reliant on another reasoning process based on negative possible outcomes that take the form…'If I don't do x, then y (poor outcome) may happen. For example, a common clinical reasoning rule of thumb states: 'If you don't put your finger in it (perform a rectal examination), you'll end up in it' (miss a rectal carcinoma and 'end up' in trouble). I suggest that for clinicians, a collection of scripts and prototypes of these 'negative cases' is drawn upon in the reasoning process. It may be that these apocryphal, negative outcome tales serve such a purpose

Table 4.5 Summary of Actors, functions and relationships for vignette 3

Actor	Function	Relationship
Student	**Action** Several cycles of planning, locating and negotiating access to patients	Facilitating
	Semiotic Quick verbally, polite but persistent, smart	Facilitating
Junior doctor (A&E)	**Action** Locates successive patients	Facilitating
Junior doctors (ward)	**Semiotic** Unwilling to help students	Inhibiting
Junior doctors (Common room)	**Semiotic** Ignore student presence	Inhibiting
	Action Storytelling and teaching	Facilitating
Patients	**Action** Absent due to having tests (X-Rays)	Inhibiting
Material (Object of knowledge)	**Action** Students unable to start computer	Intermediary
Material (Instrument)	**Action** Students do not know how to remove or replace simple bandages and dressings	Inhibiting
	Action Students do not know location of replacement dressings	Inhibiting
	Semiotic Students fear causing extra work for staff in finding and re-applying bandages	Inhibiting
Material (commodity)	**Action** Large numbers of doctors and small numbers of patients gives time for learning	Facilitating

Figure 4.4. Summary of Network development for vignette 3
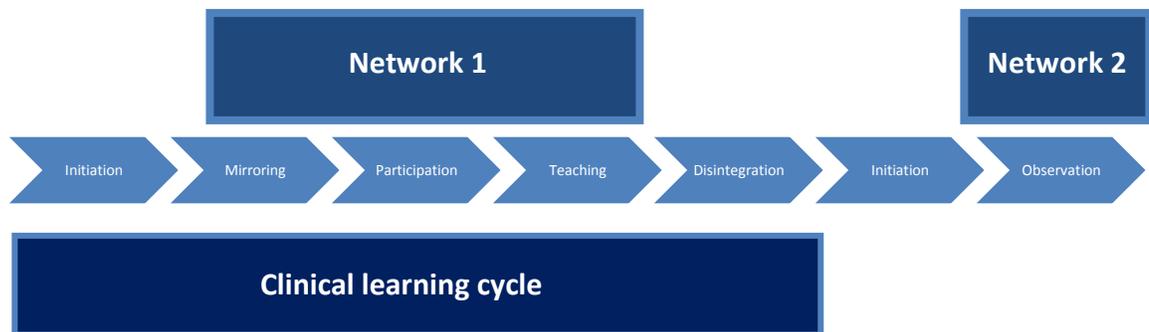
As part of their off-timetable learning, students would often attend routine service delivery meetings such as case conferences. For the most part, students were observers – being unacknowledged and the technical nature and speed of most clinical conversations running well ahead of them. These conversations were often subtly competitive regarding knowledge of more obscure aspects of medicine, which could make student learning more challenging. In addition, students would not be sufficiently au-fait with the patients to contribute.

However, in the next vignette, a student attends a case discussion meeting. This vignette is included because in this instance the student has been undertaking a self-selected study unit on the ward for three weeks (instead of the usual one week for clinical placements). This made a telling difference to his ability to initiate a participatory learning process.

The vignette demonstrates a single learning process (participation) within a network. This enables comparison with vignette 3, which also briefly illustrates a participatory process. The vignette also demonstrates the effect of increasing clinical attachments from one to three weeks.

12.05 The case presentation meeting is very informal and relaxed. There are 5-6 consultants, 3 medical students and some junior doctors. There are no nurses or other **AHPs**. The students have been on the ward for 3 weeks now (as part of their **SSUs**) and ask questions frequently and seem very at home. Note telling difference between these students and the usual 1 week attachment students who never contribute – this is both social and material challenge. On one-week attachments, they don't know where things are and also don't know who anyone is. A consultant presents the case – delay in feeding - and various possible causes are suggested. Just as the presentation is finishing, X the medical student suggests two vital missing parts to the case, based on quite detailed knowledge of the case

' is this the family where the other child had that head injury and now there's a child protection issue?'
The presenting consultant puts his hand to his head
12.12 There are a series of fast bleeps on several bleepers; '**paediatric cardiac arrest** Bramble yellow' - as a dad I feel a bit sick – they are terrifying words to hear. One consultant moves quickly; there is a brief discussion;
'That's probably……..,'
The medical student pipes up again;
'there's also………. in that bay'
The consultants look at each other again and one says;
'*I think I'm going to wander across and take a look'*
Several more follow. It's totally calm but even as a fellow doctor I am not in this world – to me as a dad it's just terrifying. The meeting is promptly terminated.

4.4.2.1 VIGNETTE 4 ANALYSIS

1)   NETWORK INITIATION

The material timetable actor exerts facilitating action functions in bringing together student, teacher and knowledge source (case presentation) actors.

2)   NETWORK MAINTENANCE

The network is maintained by the action function of consultants giving clinical case presentations.

In this vignette, a student actor volunteers clinical information. Through detailed knowledge of the patient, he is able to offer advice that influences the management plans for the patient and in this way is taking part in delivery of patient care. The student is aware of child protection concerns for another child in the extended

family and by implication, raises the possibility that the cause of poor growth may be due to adverse social circumstances. This is not something that had formed part of the consultant's differential diagnoses that had included many complex physical causes. The discussion is curtailed after a few minutes by a cardiac arrest bleep. The student again exerts semiotic functions in contributing to the discussion regarding which infant might have arrested and again, alters management responses. In both cases, the student contributes to the work of the team by semiotic functions (speech), which are acknowledged, accepted and acted on by senior team members. In a similar manner to vignette 3, the participatory process is short – lasting a number of minutes and involves student, teacher and knowledge-source actor (patient or patient-related notes).

What appears to distinguish participative practices from parallel practices is the student ability to form facilitating relationships with service network actors (usually doctors) relating to patients or patient care. Most commonly, this was through exerting semiotic functions (speech), that generated a facilitating relationship with a service provider. This was most commonly a junior doctor, but could also include interactions with consultants, senior trainees or nurses. Less commonly, I observed students performing other participatory processes such as writing in notes and locating results, although I only observed fifth-year students doing this. The Caucasian student actor projects competence in being particularly well-groomed, very smartly dressed and speaking in what I perceived to be a clipped, non-regional accent that appeared to gain the confidence of senior staff (similar characteristics are outlined for student S in the exemplar vignette). This set of semiotic functions appeared highly predictive of facilitating relationships between student actors and service network knowledge-source actors. A more detailed analysis of this set of functions was not possible due to the limitations of transcribing adequate information in the time available. Recording via tape, photograph or video may prove an interesting avenue of further research in this respect.

Facilitating semiotic functions include exceptional motivation resulting in action functions such as being present on the ward until late in the evening clerking

multiple patients. The student has been present on the ward for three weeks instead of the usual one week. In this time, he has become well-known amongst the staff and has had time to negotiate material inhibitors highlighted in previous vignettes. His emerging social integration manifests itself in a confidence to make contributions to clinical discussions and some of the consultants are familiar with his name. His contributions were the only ones I was able to observe in this context.

3)   NETWORK DISINTEGRATION

A formally timetabled learning network is terminated by the service network. This was a frequently observed phenomenon on other timetabled activity such as ward rounds and feedback sessions.

4)   NETWORK OUTCOMES – LEARNING OPPORTUNITIES FOR TECHNICAL PROFICIENCY

Network outcomes (while the network lasts) for the student are multiple. Through concentrating and following the clinical discussion, the student is able to observe experienced clinicians articulate diagnostic reasoning that incorporates a large corpus of medical knowledge. The student may therefore have the opportunity to learn how to apply general medical knowledge to a particular case, but also how this knowledge is applied within the organisational constraints operating in a modern hospital. These contextual considerations applied to clinical knowledge were seldom observed being taught outside patient-specific instances. Through following this discussion, the student interjects at the appropriate point in the discussions and makes a contribution to the management strategy for the patient. The challenges in following technical conversations between the consultants were considerable as the connections between the physiological principles being used were complex but happened quickly because of frequency of use (see vignette 5 for a further example of this).   Despite all students being equipped with smartphones to record these conversations (and more formal clinical teaching), I never observed this. Notwithstanding issues of consent and confidentiality,

analysis of recorded work-related conversations appeared an underutilised resource.

Table 4.6 Summary of Actors, functions and relationships for vignette 4

Actor	Function	Relation
Principal actor Student	**Semiotic** Appropriate dress, accent, motivation	**Facilitator**
Knowledge source Consultants	**Semiotic** Conversations regarding clinical cases	**Ambiguous** Technical nature inhibits for majority of students. Student ability to follow conversation in this vignette facilitates network
Knowledge object Timetable	**Action** Brings necessary actors together	**Facilitator**
Instrument Bleeps	**Semiotic** Cardiac arrest – 'alert' signal	**Inhibitor**
	Action Removes knowledge source from network	**Inhibitor**
Smartphones	**Action** Recording technical conversations regarding **pathophysiology** and **management**	**Intermediary**

Figure 4.5. Summary of Network development for vignette 4

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                    ┌─────────────────────┐
                    │  Learning network   │
                    └─────────────────────┘

    ┌──────────┐ ┌──────────────┐ ┌──────────────┐
    │ Initiation │ │ Participation │ │ Disintegration │
    └──────────┘ └──────────────┘ └──────────────┘

    ┌─────────────────────────────────────────────┐
    │           Clinical learning cycle            │
    └─────────────────────────────────────────────┘
```
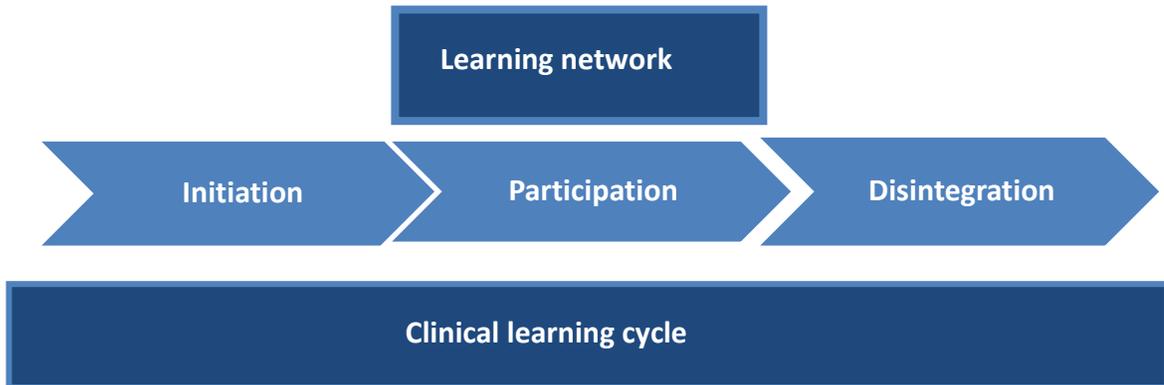
4.4.3   SUMMARY OF PARTICIPATORY LEARNING PROCESSES

Table 4.7 Summary of participatory learning processes

Characteristics	Uncommon, short lived (minutes)
Examples	• Students clerk patients that have not been seen and feedback findings to the service network. • Students observe clinical case discussions and contribute verbally • Senior students write in patient notes and try and retrieve results as part of a ward round
Actors	Student + Service network actor + Knowledge source actor (patient or patient-related content)
Proficiency outcomes	Knowledge appropriation and clinical reasoning is patient specific. Students learn in a more informal, work-oriented context and practise communication skills, diagnostic skills and clinical examination. Some of this is supervised.

4.5   OBSERVATIONAL LEARNING PROCESSES

Student learning involved attending various meetings and discussions and students would join them either as formally timetabled activities or through following junior doctors as part of off-timetable activity. In the following vignette, students are attending a clinical handover. However, in contrast to vignette 4, they do not know the ward patients.

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09.00   I get to the ward, but the room is empty, there is a handwritten sign on the door '*handover in tutorial room'*. Handover has gotten so big it's moved to the lecture room.

The consultant looks around the room but doesn't recognise many people so he wants to know who everyone is – not names but roles. There are 3x yr3 students, 3x yr4 students and 7 SHOs. He looks at me; '*o yeah you.'* ?Dislocation – Large numbers of doctors

Then we are off – the first patient has a severe infection….*'right this one's got a **base deficit**, the **IO line** is still in situ, the **vascular access team** just phoned from **resus** saying can we have a look at some point, he's had **cephalexin** and he's got a **creat of 250,** the **renal team** calculated a **7litre base deficit based on his sodium**, but he's the same weight, the glucose is trending downwards'*
? Full-on technical language

Even to a semi-insider this language and logic is difficult to follow. There is an enormous amount of physiology that lies behind this interaction.

Following this there are further cases – about 20 in all and these include meningitis, abdo pains, eating disorders and 4 overdoses. This would be perfect learning in terms of cases and also medical talk.

It's a big learning opportunity – lots of terminology (in fact the students are exposed to a huge amount of medical talk during the day). But the rate at which it happens is too fast.

9.26 *'Am I in the right place?*' It's another 3rd year stude – I saw her hanging around on the ward earlier. She has been waiting on the ward. ?Dislocation

The studes look dazed and confused

4.5.1.1 VIGNETTE 5 ANALYSIS

1)   NETWORK INITIATION

Students exert minimal action or semiotic functions to initiate or maintain the network as this is part of a service network.

2)   NETWORK MAINTENANCE

Despite constant interruptions via action functions of moving room location and students and doctors continually arriving and departing, the network is more stable and less prone to minute-by-minute variation according to clinical service needs (although as vignette 4 demonstrates, service priorities can bring these networks to

an instant halt). Students exert few observable semiotic or action functions whilst observing and few relationships between the actors are therefore discernible; with student presence barely acknowledged. In this sense, this vignette resembles the observational processes recorded in vignettes 2 and 3, where students appear relatively unacknowledged and dislocated. In this vignette, semiotic functionality to initiate facilitating relationships appears difficult, as again many of the people present do not know each other. Because of the diminished relationships between the student actor and the knowledge source actor (consultants), a learning network was only faintly discernible here. The students appear 'dazed and confused' and do not appear to be exerting the action functions normally associated with learning activity such as active listening, questioning or note-taking.

Fenwick (Fenwick, 2011) refers to these weak relationships as partial connections that produce partial networks. Observational learning processes may demonstrate a partial network, producing partial learning.

In practice, students were rarely totally ignored. However, there often appeared to be a disparity between the student action function of presence and semiotic verbal or non-verbal acknowledgement of this presence by service actors. I have previously highlighted the ability of senior service network actors to 'filter' out elements of their environment (vignette 3) and suggest that medical students can be subject to this filtering process by senior service network actors.

It is difficult to conceive of no learning taking place with such rich sources being immediately to hand, yet I did not observe students taking notes, recording the conversations (a potentially rich source of learning) or trying to follow the conversations in either observational process observed in vignettes 2 and 5. The short but dense technical conversation in this vignette, covers a substantial part of the clinical management of **sepsis** and **acid-base balance** – but is communicated in a highly technical manner with the logical shortcuts and use of maxims that characterise expert performance (Eraut, 1994; Schon, 1983).   Students bitterly complained about similar observational experiences, for example watching outpatient clinics or surgical lists (as part of the formal timetable), when their presence was not acknowledged.

I therefore propose that in this set of observations, it is the mutual exchange of semiotic functions (which may or may not be verbal) between learner and knowledge-source, that signifies the student as a legitimate participant and allows learning to commence. It appears that unless this explicit exchange occurs (and is maintained), then despite rich learning experiences being available, student action functions associated with learning appear substantially reduced. This may result in reduced student learning. I frequently observed students 'switching off' whilst engaged in observational learning processes and clinicians commonly referred to this as 'the 20-minute glaze over.'

3)   NETWORK DISINTEGRATION

Not demonstrated in this vignette

4)   NETWORK OUTCOMES – LEARNING OPPORTUNITIES FOR TECHNICAL PROFICIENCY

Despite rich learning opportunities, the students project semiotic signals that I interpreted as disengagement. The students do not exert action functions associated with learning such as take notes or engaging in conversations (as in vignette 4).

Table 4.8 Summary of Actors, functions and relationships for vignette 5

Actor	Function	Linkage
Doctors	**Semiotic** Discuss clinical cases in highly technical language at a rapid rate	**Inhibiting**
	Semiotic Student action function of presence does not initiate equivalent semiotic response	**Inhibiting**
Students	**Semiotic** No visible verbal or non-verbal acknowledgement by the working team (apart from a formal identification of their role)	**Intermediary**
Material commodity	**Action** Large numbers of students and junior doctors present (similar to vignette 4) necessitating moving to a larger room	**Inhibiting (reduces semiotic interaction possibilities)**
Patient related knowledge source	**Action** Large number and variety of clinical cases	**Facilitating**

Figure 4.6 Summary of Network development for vignette 5

Partial network formation
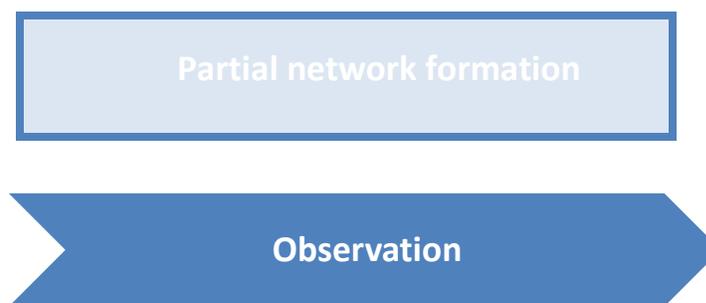
Observation

Table 4.9 Summary of observational learning process

Characteristics	Relatively frequently observed Can last hours
Examples	Students attend meetings, ward rounds, surgical lists, audit meetings, case reviews, outpatient clinics.
Actors	Student – Service network actor
Actor-relations	Partial or absent semiotic acknowledgement of student action functions (presence)
Outcomes	Faintly detectable or absent observable learning action functions (writing, asking questions)

4.6   NETWORK INITIATION FAILURE

The majority of observed student time in off-timetable learning was spent trying to initiate learning networks and the majority of these attempts would end in failure. This is reflected in the following vignettes. Network failure analysis may be helpful in predicting the actors, functions and relationships involved and point a way to making network initiation (and therefore learning opportunities) more successful. In the following vignette a student has planned and located a suitable patient but now needs to negotiate access.

4.6.1   VIGNETTE 6 - BRIGHT BLUE SHOES

This vignette demonstrates some student semiotic functions that combined with material inhibitors makes network initiation difficult. Network analysis follows a slightly different structure as initiation, maintenance and disintegration stages were not observed.

18/06/13
2.23 Searching for patient with ST
3.15 Back on the ward. We go back to the patient that DR pointed out on the ward round. It's the baby with all the wires and machines hooked up (see Figure 4.7 below). But the mum now has a visitor. Whilst the student waits, I reflect on her demeanour. She is Asian in origin, extremely smartly dressed - wearing a black

short dress, make up and bright blue high-heel shoes. She appears to 'over-project' semiotic signals of competence; to the extent that it appears brash and incongruent with her stage of learning.

ST: '*Do you want to know what I'm thinking?*'

Me: '*yes*'

ST*:' I'm thinking that I can't remember what DR told me about this patient because I couldn't write anything down because there isn't anywhere to put anything (pens and paper), so now I'm going to look in the notes*'

Why don't students use their i-phones /tablets to record or write what the teachers say? – also, see earlier reflection about there not being any room to put things

She looks for the notes and sees a nurse

(Loudly) '*excuse me can you tell me about PT*'

…but it's over the top and her attempt at confidence comes across as pushiness and the nurse looks irritated. At this point the patient notes she has taken from a big trolley fall apart – a large section (about 100 pages or so) falls out of the binding

ST; '*O god, did I do that? I didn't do that did I?*'

The nurse says;

''I'm staying out of this'.

ST looks a bit shaken but carries on talking, she is trying to piece the notes back together, but they are all jumbled up – this is going to be a big job.

'If she isn't done talking to her friend by the time I'm finished with these notes I'll just have to go in'.

The student stays for 10 minutes and starts to fix the notes, but then leaves them and goes to the library. She does not interrupt the patient visit.

4.6.1.1 VIGNETTE 6 ANALYSIS

1)   INITIATION FAILURE

The student actor shows considerable action functionality to try and initiate the network. Locating the patient took considerable time, as the student did not remember where the patient was and searched several wards looking for the patient – despite the consultant telling the students where the patient was on the ward round.

The student actor now uses semiotic functions such as dress and speech in an attempt to form a facilitating relationship with a nurse actor in negotiations for patient access - although in this case it appears too much. The interaction between student and a patient gatekeeper (such as nurse or junior doctor)

preceded the formation of all clinical learning networks involving patients. Unlike America (Becker *et al*, 1961), students did not feel empowered to approach patients independently. In the interaction between the student actor and the service network actor, semiotic student factors (dress, accent, extroversion, projected competence) seemed to influence whether the student was thought suitable to approach the patient. Nurses or junior doctors never assessed technical competence or student seniority prior to access.

In the vignette, the relationship between student and service network actor (nurse) seems ambivalent; although access is granted, the students' semiotic projections are not quite right and seem to irritate the nurse. The nurse declines subsequent opportunities to establish collaborative working through conversation and help in piecing together the notes.

Network initiation is now inhibited by a service network actor (visitor) and again the student displays action functionality in attempting once more to initiate a learning network by locating another knowledge source actor (the patient notes) to learn from. When the notes fall apart, the student promptly exerts more action functions in attempting to repair them. The student exerts further action functions by waiting for the visitor to finish with the patient and does not appear empowered to interrupt. She does not implement her plan to interrupt after ten minutes. This is in contrast to data from ethnographic studies from other countries (Becker *et al*, 1961), but is consistent with ethnographic data from the UK (Atkinson, 1997).

Despite the persistent use of action functions by the student to facilitate relationships between student and learning source, a number of material actors form inhibiting relationships. The student is unable to negotiate the notoriously difficult properties of the paper notes, which are thick and poorly bound by thin plastic holders. The student difficulty and lack of control with the notes stands in stark contrast to the senior student in vignette 4.

Lack of simple instruments such as notebook and pen (the student had nowhere to put them due to clothing restrictions) means the student is unable to write down important information about the location of the patient. Here paper and pen are again characterised as intermediaries.

Finally, the vignette and photo (figure 4.7) portray the highly technical nature of modern care. From autobiographical experience and data obtained through the pilot focus groups, I suggest that students and doctors experience internal semiotic anxiety when approaching ill patients with technical instruments surrounding them. I suggest these technical instruments exert semiotic functionality by accurately transmitting signals such as 'complex' and 'ill patient'. For small babies this semiotic functionality can be especially strong, as monitors are easy to dislodge, resulting in alarms sounding. The technical-material nature of this case is demonstrated in the photograph of the same baby being subsequently examined by a more senior student.

Figure 4.7 – Photograph of baby in vignette 6

Close inspection of this photograph reveals a stethoscope hanging over the end of the cot (the sides of which the student leans over, as he is unable to operate the cot-side mechanism). The stethoscope is here for immediate use, as this baby's heart would stop from time to time. Consultants discussed this with parents and students as 'the baby 'being naughty'. A **bag and mask** lie out of view and are

additional aids at cardiac arrest. To the right lies a cardiac monitor, oxygen saturation monitor, **ventilator,** and **drip delivering inotropes**.

It is possible to characterise the ventilator, drip, resuscitation equipment and monitors therefore as inhibitors; exuding semiotic functionality by transmitting signals such as 'danger, ill baby'.

The nurse actor again maintains an ambiguous relationship with the student actor in this vignette. There are weakly facilitating relationships in that the nurse does not stop the student from trying to see the patient. However, verbal information about the patient or help piecing the notes together is not forthcoming. Here the nurse is weakly inhibitory.

Despite repeated action functionality by the student, the combination of inhibitors means a clinical learning network fails to establish itself. The dominant inhibitor appears to be the presence of a visitor. Student actors appeared to exert little power in clinical environments.

After 10 minutes, the student disassociates entirely from the clinical environment to participate in a more stable learning network of computers and fellow students in the library. The observation covers a period of approximately 15 minutes (although the student had been trying to locate the patient for over 45 minutes before the vignette starts), and accounted for the student's total time in the clinical environment for that afternoon. This particular type of vignette was the most commonly observed clinical learning scenario as the majority of junior student attempts at network formation were unsuccessful.

Vignettes 1 and 2 illustrate that highly specified curriculum content translates poorly into this learning context. Here, there appear to be additional challenges with the process (timetable) of learning. Students were timetabled to clerk patients in the afternoons, but this was the time for lunch, rest and visitors. Superimposed on this timetable was another timetable of afternoon ward rounds (vignette 2 demonstrates interruption of student mirroring process by a ward round). Consultants therefore again substantially translated the timetables advising students to attend in the evenings. This was largely ignored and I rarely observed student presence on the ward after 5pm.

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The student becomes acquainted with a material knowledge-source actor important for service delivery (the notes). There was no observable contribution to clinical knowledge, skills or reasoning. Student exits clinical placement environment to learn for knowledge-based assessments.

4.6.1.2 VIGNETTE 6 SUMMARY

Table 4.10 Summary of Actors, functions and relationships for vignette 6

Actor	Function	Relationship
Principal actor Student	**Action** Locates patient, attempted negotiation, repair of notes, waiting for visitor	**Facilitator**
	Semiotic Projection of competence Low apparent empowerment	**Inhibitor**
Service network actor Patient visitor	**Action** Presence in patient's room	**Inhibitor**
Service network actor Nurse	**Action** Does not stop access, does not help student negotiate a way out of situation	**Ambivalent**
Object of knowledge Patient notes	**Action** Difficult, unwieldly and fall apart	**Inhibitor**
Instrument Technical equipment	**Semiotic** Induce fear of doing harm to ill patients	**Inhibitor**

4.6.2   VIGNETTE 7 - WHERE'S THE DOCTOR?

Students were sometimes successful in negotiating informal teaching from service network actors such as doctors. However, in this vignette, the teacher has not arrived. The vignette extends some of the principles identified in vignette 6 in illustrating just how far students exert action functions to initiate learning networks. The vignette further highlights material inhibitors present in the service network and how students negotiate these through action functions. As outlined, network initiation was time consuming, rarely successful and accounted for the majority of student time spent in this environment. Network initiation time is not reflected in

conventional accounts of student learning time (Van-Hell, Kuks and Cohen-Schotanus, 2009).

2.45 Still no sign of the teaching consultant (DR) – we have been waiting half an hour now.
ST *'She definitely said she would meet us here for the teaching'.*
They decide to go and look for her. So we walk out of the room and turn left – there is a door here that leads to the ward but we don't know the code, so we turn back around and walk back to the main entrance of the ward. The students can't get in so we wait for a patient to come out. Now we are on the ward the students go to blue team to ask the nurses where DR is.
'Try the secretaries'.
But they don't know where the secretaries are. So they decide to try and clerk the patient that DR has suggested. They go to a separate ward (Bramble yellow)..
ST *'Hi we are the medical students, do you know where PT is?'*
NURSE 1 *'Try Bramble blue, they will know'*
So we go back to Bramble Blue (we have just come from there).
NURSE 2 *'No she's on Bramble yellow'*
ST *'But we've just come from there, they told us to come to you'*
NURSE 2 *'That's funny we are a surgical ward'*
The two nurses can see each other down the corridor, but there is no communication; they don't seem to acknowledge each other.
ST; *'OK let's try and phone the secretary to see where she (DR) is'*
2.55 Now the students have to learn to negotiate the hospital automated internal telephone system. To work this you need to know the name of the secretary and they don't know this, so they wait for the nurse to finish her job and ask her;
Nurse 3 *'Yes she's called E'*
So they try again, there is no reply and the answerphone says '*please send an e-mail.'* So now they wait for the nurse to finish another job and she looks up the e-mail. So they try and e-mail but their phone can't get any signal and they can't use the wireless system.
3.35 So now they decide that maybe DR is in outpatients, so we go to outpatients but she isn't there either, so we finally go back to the ward. At this point they decide that they have to do a presentation tomorrow and leave the ward. Here there is another problem because the door is faulty and you have to wait after pressing the button and then push quite hard. They wait for someone to come and do this for them as they can't figure this out and they leave the ward.
4.13 It's excruciating to watch - as they wait to be shown out one of them says;
'*That must have been great for your research but that was shit for us.'*

1)   INITIATION FAILURE

Here, two students attempt repeatedly to initiate learning networks without the facilitating action functions of more senior doctors. Doctors appeared more empowered and were able to locate patients and bypass access negotiations with nurse actors.

The nurse actors in this vignette did not appear to know each other and did not know the students – again students appeared to be dislocated in this respect. This contrasts with vignette 3, where the students had been present on the ward for three weeks, rather than the usual one week and had far more success in negotiating with nurse actors. I therefore suggest that the time students spend in a particular site may have an effect on semiotic acknowledgement and reciprocation, which may manifest itself in increasing success in negotiating access to patients with nurse gatekeepers.

As previously discussed, network initiation involved negotiating a number of material actors and again this vignette confirms their role. Here, doors, automated telephone systems, wireless networks, mobile phones and access to software systems all form either intermediary or inhibiting relationships with the student actors. In contrast, for more permanent service network actors such as nurses and consultants, these material actors served to facilitate relationships. As previously outlined, student inability to negotiate these material actors often served to inhibit learning network formation and consequently diminished the learning opportunities available. However, vignette 3 demonstrates how, even after a period of three weeks on a ward, students were able to negotiate many material actors.

2)   OUTCOMES – LEARNING OPPORTUNITIES FOR TECHNICAL PROFICIENCY

Students are exposed to the role of multiple material actors present in the service network. No observable contribution to clinical knowledge, skills or reasoning was observed however.

However, potential learning concerning the hidden curriculum may be substantial. For instance, students may reflect on the attitudes of the nursing staff towards them. Students exit clinical placement for the library to learn for knowledge-based assessments.

Table 4.11 Summary of Actors, functions and relationships for vignette 7

Actor	Function	Relationship
Student	**Action** Repeated attempts to plan, locate and negotiate access to knowledge source actors	**Facilitating**
Teacher	Potential co-ordinator of student learning	**Intermediary (absent)**
Nurse	**Action** Patient location made more difficult	**Inhibiting**
Material (Instruments)	**Action** Door mechanisms, door entry codes	**Inhibiting**
Material (Objects of knowledge)	**Action** Telephones, automated dialling system, smartphones, e-mail	**Intermediary (unable to be used)**
Material (Object of knowledge)	**Semiotic** The assessment actor draws the student away from clinical environment to revise for knowledge tests.	**Inhibiting**

Table 4.12 Summary of network initiation failure

Characteristics	• Most frequently observed • Accounts for the majority of time spent in clinical service network
Examples	• Student over-projects semiotic competence function • Visitor (or other service network actor) interrupts • Excessive material inhibitors present
Actors	• Time commodity – Acts as inhibitor if placement is too short to adequately negotiate material and human inhibitors and intermediaries • Student – Appears to project low levels of semiotic power • Assessment – May encourage students to exit clinical learning environment
Actor functions	• Student fails to exert sufficient facilitating action or semiotic functionality to initiate networks • Technical machinery projects semiotic functions (danger) to students • Material actors exert action functions, being present but resisting use
Relationship patterns	• Material actors frequently inhibitors • Nurse actors frequently ambiguous
Network characteristics	• Not applicable - Excess of inhibitors and intermediaries prevents network formation. • Students leave clinical placements for more stable library / home networks to revise for knowledge-based assessments
Technical proficiency outcomes	• None observable • Students may reflect on professionalism issues • Students may learn knowledge on leaving clinical environment for library or home.

Students found episodes such as this profoundly demotivating and almost always exited the clinical service network at this point. For some students, repeated episodes like this, coupled with semiotic influences from the assessment actor, drew them increasingly away from learning in the clinical environment, to learning in more fixed, durable networks such as the library or at home. I have termed this particular action as a dissociative process.

4.7 DISSOCIATIVE PROCESSES

In preliminary focus groups and interviews, students talked at length about other students dissociating themselves more-or-less entirely from clinical learning. They estimated that between 20-40% of their colleagues adopted this approach – presenting themselves at the minimum level necessary on clinical placements to fulfil assessment and attendance requirements.

By definition, I was unable to easily observe students who did not attend clinical placements often. Nevertheless, through contact tracing I was able to identify several who talked to me about their reasons for dissociating from the course. Dissociation led to one of two behaviours: going to the library, pending a learning activity later in the day, or going home if no further activity was planned. Students frequently returned home even if subsequent learning activities were timetabled and would ask colleagues to sign in for them or give apologies, citing illness. This was a cause of considerable irritation for the students who were asked to do this, although few ever declined.

At home, students claimed they took part in study using computers in a similar manner to the library. A transcript of an interview with a student who claimed to have dissociated where possible from clinical learning forms the basis for the following vignette.

4.7.1 VIGNETTE 8 'F'

Extract of interview with ST 19/06/13

<u>Tell me about your learning</u>
'There's a lot of wasted time, for instance today I was in ED. I was there at 8.30 and saw 1 patient and it was the same for my friend until 12 and then we left'
'Yesterday we were on B ward, a lot of it comes down to the juniors, they say come here look in the BNF, write in the notes, you learn a lot more that way than just following the consultants around'
For 2-3 days this week the doctors like don't know you so they don't ask you to do stuff
That's what it's like, a lot of the time you have the feedback (assessment case presentation) on Wednesday or Thursday and you can have 2 days off and stay at home – there is very little structure'

Talk me through exactly what happened today

*I'm doing collapse and falls (medical school curriculum case) this week so I went to ED looking for collapse and falls, but there was no one there with that. There was shortness of breath, but that's no good. Then they say one (a collapse) is coming in in 15mins with **UTI** and needs a catheter, but then when she arrived, they told me to wait outside because it's an intimate exam. I did get to hold the bottle of saline for 30 mins, but that was it for today.*

I learned nothing. The consultants are like you are part of the team and I'm like all ready to go but the nurses are like, 'no stand outside'.

So that was the case? Did you get to speak to the patient?

No

Can you go back this afternoon?

It's not timetabled like that

Basically you go in on Tuesday and it's like Hi and you go in on Wednesday and get a patient and then you are done for the week – you don't need to get any more patients

How many students learn like this?

The ones who do it out of laziness – maybe a handful – they know how to play the system. They ask: Is the consultant…. is he good… is he harsh…. watch out for that guy, or maybe it's professionalism week, (week when students' professionalism is formally assessed) then they go in all the time, smartly dressed, 10mins before the consultant gets there.

Word gets around; who is strict, who is easy

It's important because you want to avoid being called (he pauses)……. Say by the ….. team…..you want to avoid…..stops…

The ones who go in but get pissed off and go home? maybe 30 or 40 students (50% of the year) who don't think it's a good system and do the minimum.

How often does this feeling happen, this feeling where you just think right that's it I'm going home

About 2-3 days every 2 weeks.

Like yesterday we were in for the whole day but today we were only in for an hour - yesterday was like 3 hours of experience, but like today it's been nothing, so like the average productive work over the last 2 days is an hour and a half out of 16 hours.

If you added up all the wasted hours you could feed the whole of Africa

I've heard of people waiting for 3 hours for a feedback session and then it's cancelled.

I know you doctors work hard but there are a lot of times when we are working hard as well and I know we are only medical students, but we go out of our way.. are like waiting on the wards for 3 hours for teaching and then we are told its been cancelled, even though we are only students we could have used this time better, researching and stuff… I'm not saying I'm an angel Like today I woke up at 7 o clock and I've learned nothing - I could learn more going down my local post office than standing there holding a drip.

I thanked F and turned off the i-phone. I was intrigued by what he had said earlier in the interview and asked if he was happy for me to continue noting.

What did you mean when you said you have to watch out or the consultant will like call you?
'Well like one of my friends was doing the X firm and like one of the consultants was like 'you are a fuckwit, you will never be a Doctor'. Then he made him say 'I am a fuckwit' and it was like in theatres and he had to stand there with everyone. ..you have to be ready..if he did that to me I would take him down'
We talked about ways of handling conflict situations.

4.7.1.1 VIGNETTE 8 ANALYSIS

Multiple inhibitory relationships appear to be operating.

Firstly, there appears to be a divergence between the semiotic and action functions of the timetable actor. The semiotic function suggests facilitating relationships through sustained student presence in the department. However, attendance at certain times is prohibited by the action functions of service network actors, resulting in inhibiting relationships between student and knowledge-source actors.

Secondly, there appears to be a similar divergence in the semiotic and action functions of the curriculum actor. The curriculum projects semiotic functionality through articulating that the student learns about 'collapse and falls'. However, this case is not present in the department when the student is there. Case specificity is not achievable in an Emergency Department context and so significantly limits the action function of relevant cases being available.

It is interesting to note that a 'shortness of breath' case arrives in the department, but this is ignored by the student. Medical students are strongly motivated by assessment (Newble and Jaeger, 1983), having reached medical school through achieving scores in assessment that lie well outside societal norms. In this case, a clinical case – despite being a potentially rich source of learning - is not relevant to assessment and so is overlooked. Newble (Newble and Jaeger, 1983) has previously noted the tendency of students to exit clinical environments if they perceive that knowledge-based examinations are more important than clinical proficiency. The assessment actor therefore appears to exert a third inhibiting relationship between student and knowledge-source actor.

When a suitable patient arrives, the nurses exert semiotic functions - communicating to the student actor that the service network over-rides the student clinical learning network. Male exclusion from female medical cases is documented in the literature (Atkinson, 1997) and is supported in this instance. Furthermore, observations of the male student actor semiotic functions suggest an unkempt, unshaven appearance, a non-caucasian cultural heritage, reticence of expression and regional accent. As previously suggested, external semiotic projections of competence strongly predicted whether relationships would form or not, between student and other service network actors.

Finally, the student relates a tale of humiliation by a senior doctor similar to many that circulated amongst the student body. Certain service network actors appeared to exert particularly strong semiotic functionality in this respect and were well-known amongst the student body. In this case, the human actor appears to form inhibiting relationships with student actors through projection of semiotic functions such as fear of attending their particular speciality. The student ventured that this incident was attributed to a surgical firm but declined to divulge the name of the consultant for fear of reprisal, but was keen that the incident be highlighted. Despite multiple inhibiting relationships, it is clear that the student actor has exerted considerable significant action functionality; trying repeatedly to initiate learning networks in the clinical environment.

In a similar manner to previous vignettes, the student leaves the clinical environment and returns home to study for knowledge-based examinations, on which the student fared very well.

1) NETWORK OUTCOMES – LEARNING OPPORTUNITIES FOR TECHNICAL PROFICIENCY

The student exits the clinical learning environment for another off-timetable network. Here, the student learns general clinical knowledge in decontextualised form in order to pass knowledge tests.

4.7.2   SUMMARY OF DISSOCIATIVE PROCESSES

Repeated failure to initiate networks (vignettes 6 and 7) or formation of partial networks after much effort (exemplar vignette and vignette 5), may result in negative feedback loops, exacerbating dislocation and in some cases resulting in disassociation from the clinical placement environment (vignette 8). It is possible that some of the semiotic functions identified in the literature and observations such as passivity, feeling out of place and unable to contribute to the work of the service network may be manifestations of this process.

Some of these findings have considerable implications for learning and these are further analysed and discussed in the following chapter.

CHAPTER 5 – UNDERSTANDING CLINICAL LEARNING USING NETWORKS

The first part of this chapter further develops the analysis to present an initial interpretive framework of the factors that influence how different kinds of learning networks function to support the development of different kinds of technical proficiency amongst junior medical students. In tandem with this, the pedagogical implications are discussed in relation to the observation site.

The second part of this chapter discusses the wider implications of the findings for teaching, learning and research and finally discusses some of the advantages and drawbacks of the approach used.

Several novel approaches to clinical learning are presented, including the systematic analysis of material actors, analysis of new human actors, how human actors interact to initiate learning through semiotic recognition practices, how learning takes place through learning networks and constituent processes and finally, how learning can be affected by semiotic filtering, weak networks and student dissociation.

I propose that these novel interpretations of clinical learning have been achieved by using three original approaches. Firstly, the use of Actor-Network-Theory to analyse observational data from a focussed ethnography of clinical learning that includes off-timetable learning (a major component of the student experience). Secondly, adaptation of ANT to provide a fine-grain analysis that identifies a microstructure to clinical learning. Finally, in order to articulate this micro-structure, a novel analytic language has been developed and deployed.

The analysis may be summarised through a set of four network premises that encapsulate the main findings, but may also serve as a design tool for placement learning. These premises are summarised below and then discussed in further detail.

1. **Networks:** Clinical learning opportunities arise through students initiating and maintaining learnng networks, consisting of a relationship between student actor and knowledge source actor. Networks appear to exhibit microscopic and macroscopic properties:

    a. Microscopic properties of networks are attributable to three variables:

        i. Other human and material actors.
        ii. The physical presence (action functions) or non-physical properties (semiotic functions) of actors.
        iii. Relationships between actors:
            1. Facilitating relationships
            2. Inhibiting relationships
            3. Ambiguous relationships
            4. Intermediary relationships

    b. Macroscopic properties refer to
        i. The 'shape' of networks (their general characteristics)
        ii. How networks produce effects such as learning
        iii. How networks interact with other networks
        iv. How networks change over time (initiation, maintenance and disintegration)

2. **Network initiation**: Student actors exert action and semiotic functions to initiate learning networks:

   a. Action functions

      i. Planning

      ii. Locating knowledge source actors (human or material)

      iii. Waiting for acknowledgement by service actors (as students may be subject to semiotic filtering by network actors)

      iv. Negotiating access

   b. Semiotic functions

      i. Projections of competence – including dress, accent and speech patterns.

3. **Network maintenance**:

   a. Semiotic recognition of student presence by service network actors is necessary for network initiation and maintenance.

   b. Networks consist of repeating actor combinations. These different actor combinations produce certain types of learning processes within learning networks:

      i. Mirroring: Student + Patient

      ii. Participative: Student + Patient / Patient related knowledge source + Teacher

      iii. Teaching: Student + Teacher +/- Patient

      iv. Observing: Partial or absent relationships only between student, patient and teacher

      v. Dissociative: Student withdraws from learning environment but still learns knowledge for exams.

   c. The learning processes generate different learning opportunities for students which can result in learning

d. Students may be subject to semiotic filtering by service network actors resulting in weak or partial networks and consequent sub-optimal learning.

4. **Network disintegration**:

a. Commonly as a result from inteference from the service network.

5.1 NETWORKS

5.1.1 MICROSCOPIC PROPERTIES OF NETWORKS: ACTORS, FUNCTIONS AND RELATIONSHIPS

The principle human and material actors comprising clinical learning networks, together with their functions and relationship properties are summarised in table 5.1. These findings add detail to the areas identified through literature review as benefiting from further investigation. Findings are italicised where they appear not to have been previously fully articulated in the literature.

Table 5.1 Summary of actor functions and relationships

Actor	Function	Relationship	Examples from vignette analysis
Human actors			
Student	Action	Facilitating	*Planning*
			Locating
			Negotiating
			Waiting for acknowledgement
			Network maintenance
	Semiotic		*Dress / appearance*
			Speech / accent
			Verbal agility
			Cultural background
			Gender
			Projection of engagement / disengagement
			Knowledge base
Patient	Action	Ambiguous	Allowing/ Disallowing access
	Semiotic		Restricting / stopping information flow
Teacher	Action		Locating patients
			Locating appropriate place for teaching
			Teaching style
	Semiotic		*Acknowledgement of student presence (semiotic recognition practices)*
Nurse	Action	*Ambiguous*	*Locates patients* *Grants / denies access to patients*
	Semiotic		*Acknowledgment of student presence (semiotic recognition practices)*

Material Actors			
Instruments	Action and semiotic function	Commonly inhibitory relationship	• Phones • *Door codes* • *Cot-sides* • Notes • Patient location software • Telephones • Bleep system • *Monitors* • *Wireless access* • *Ward / hospital layout (architecture)*
Knowledge objects	Action and semiotic function	*Commonly intermediary relationship*	• Computers • Smartphones • Assessment • Curriculum • Timetable
Commodities		Variable relationships	• Student numbers • Finance models • Patient throughput

5.1.1.1 NEW HUMAN ACTORS

The results suggest that actors such as nurses and junior doctors played an important role in clinical learning networks. However, these roles appeared underestimated by the medical school. Their participation in networks was optional and erratic due to high service commitments. Increased recognition of their roles seems appropriate and may improve motivation to participate in student learning. At the observation site, training programmes for clinical teachers focus on the

needs of consultants and delivery of formal clinical teaching. Including nurses and junior doctors on training programmes and delivering training relating to off-timetable learning may result in better rates of network initiation and more stable networks. Analysis also suggests specific approaches to teacher training such as helping nurses to understand their pivotal role in access negotiations.

Junior doctors have previously provided practical instruction to students but interaction involving these two actors appeared to be lower than anticipated. Analysis suggested students were unfamiliar with material actors such as bleeps that could have improved access to junior doctors. An introduction to these material actors is now part of student clinical induction at the investigation site. In addition, students did not have time on short attachments to acquaint themselves with the junior staff. Introduction of a buddy system between junior doctors and students at clinical induction is now addressing this.

Although I did not directly observe directorate managers, clinical teachers often commented on their influence over outpatient or surgical timetables and hence time available for teaching. Further research examining the role of hospital managers may prove fruitful, as they are also responsible for co-ordinating the considerable financial interactions between medical school and hospital.

Other human actors such as students have been well characterised, but reports appear to have emphasised certain characteristics that were not observed in this work. For example, the proposed concept of learning styles is frequently emphasised, but in my observations, these characteristics appeared redundant as groups of students were present on attachments and the teachers did not know their learning styles.   Other characteristics such as the projection of competence, including dress, speech patterns, accent and ethnic origin appear less well characterised, but appeared to have significant effects on learning. Providing students with information about projected competence and providing practice in talking to knowledge source gatekeepers such as nurses may be helpful in improving network initiation rates.

5.1.1.2 MATERIAL ACTORS

In medical education, one material actor (stethoscope), has received attention as an object of power (Ajjawi and Bearman, 2012), but there does not appear to be a systematic examination or classification of the role of material actors in clinical learning.

I have described the role of material actors in clinical learning at length and have presented a classification system allowing description and analysis of their differing roles. The results of this analysis provided several opportunities to improve student learning at the observation site.

Firstly, results indicated that students did not have access to the wireless network and were therefore unable to use the medical school online curriculum resources. Discussions at a curriculum group that I convened, raised the possibility of installing a wireless system (Eduroam) into hospitals, as it became apparent that the problem of wireless access for learners extended to all five main hospital sites in the South-West of England. All hospitals are now being equipped with Eduroam that is available to all learners including nurses and paramedics. A national study of student access to online learning resources via the internet in hospital settings is now underway.

Secondly, results suggested that a major material inhibitor of student learning was access to wards. Access to paediatric, emergency, obstetric wards and theatres was controlled by access cards. Students did not have access cards that permitted them entry to these wards. Each time students wished to access the wards they were obliged to press a buzzer and wait for a nurse to stop service delivery, check student credentials and then allow access by pressing another button. At the curriculum group, hospital managers quickly became convinced of the economic benefits of student entry to wards via access cards. All students now carry access cards that allow entry to all hospital clinical areas. Again, study findings have informed a national debate about this issue (Society of Academic Primary Care – SAPC, Heads of Teachers internal documents).

Thirdly, I also observed recurring student problems in accessing hospital software systems regarding patient results, patient locations, and patient clinical notes. Each hospital department commonly had separate software systems for each of these aspects of care. Students did not attend inductions concerning access to patient software systems and were not issued with appropriate passwords. I was unable to change IT provision in hospitals for students and this remains a major impediment to student learning at the investigation site. Why students were not given passwords raises issues of power. In contrast to other studies (Becker *et al*, 1961), students appeared to exert very little power at the observation site and appeared to be overlooked when technical workplace issues were considered. This has important implications for curriculum planners, as delivery of undergraduate teaching at the observation site was heavily dependent on work-place technology such as patient software and relevant passwords.

On-site technical help, student representation on appropriate hospital committees and evaluative mechanisms capable of capturing technical issues with material actors may prove helpful in addressing these issues.

As discussed, material actors such as computers were often important facilitators of work for service network actors, who may have had time to resolve access and utilisation issues. These difficulties can be forgotten through appropriation as tacit knowledge. At the observation site, short clinical attachments appeared to contribute to difficulties in utilising material actors, as students did not have the time to resolve access and utilisation issues. I have frequently characterised material actors therefore, as intermediaries or inhibitors in network initiation and maintenance. I suggest that the role of material actors in learning is influenced by the time students spend on attachments. I have also suggested that short clinical placements can result in inhibitory relationships between student and human knowledge-source actors due to lack of trust.

I hypothesised that increasing the length of student attachments may help alleviate the challenges created by human and material actors on short placements and I interrogated literature concerning Longitudinal Integrated Clerkships (LICs) (Hirsh *et al*, 2012; Hirsh *et al*, 2007). This literature suggests that increasing the length of

clinical placements may result in better exposure to patients and clinical skills through better social ties and trust between student and teachers. However, the numbers of students involved are usually extremely small and the literature has not investigated the effects of placement length on ability to successfully deploy material actors. LICs are predominantly used in rural contexts in large English speaking countries (Australia, Canada, USA) and considerable adaptions were necessary to fit with the structures of the UK healthcare system. I implemented a pilot LIC and evaluated the outcomes (Harding, 2012a). Based on these data, the medical school has made a commitment to continuity as an organising principle of curriculum development and has up-scaled pilot programmes. Many hospital placements are now three weeks instead of one week and students spend two-years attached to a single General Practice and follow groups of patients longitudinally (Harding, 2012a).

A theme running through this work has been outlining in detail, some disadvantages of short clinical placements. However, it seems unclear what the optimum time for clinical placements should be. At present, a number of clinical placements at the observation site are still one week, providing an opportunity for comparative work.

Finally, in order to counter the disadvantages of short placements, an extended clinical induction has been implemented. This starts in the last term of pre-clinical studies and involves tutorials and lectures regarding relevant human and material actors in the clinical environment.

5.1.1.3 CURRICULUM

I have conceptualised the medical school curriculum as a material, knowledge-source actor consisting of learning information accessed by students via computers and smartphones. In this form, the results suggest that the curriculum actor was only faintly detectable.

The medical school defined in detail, the learning outcomes for placements and these related to specific patient illnesses. However, the results suggest that students did not actually see a patient with the specified condition during the

placement week. Teacher actors responded by devising an alternative curriculum appropriate to the illnesses on the ward, basing outcomes around skills that the students could adapt to a variety of patient illnesses.

The difference between prescribed and enacted curricula is not a new finding in work-based learning (Miller, Edwards and Priestley, 2010). However, a number of interventions may improve alignment. Firstly, observation and appropriate analysis of the student experience that informs curriculum planning and secondly, specification of curricular outcomes at a level allowing adaption to the differing clinical presentations on placements.

These curricular issues were examined by the curriculum group and a commitment to review learning outcomes was made. The learning outcomes for all 54 hospital placements during years 3 and 4 were changed as a result. Outcomes are now expressed in terms of learning opportunities and desired learning processes for students that are adaptable to varying clinical conditions rather than being based around specific conditions.

The findings add detail to curricular considerations highlighted in Dornan's model of clinical learning (Dornan *et al*, 2007) that emphasise detailed articulation of learning objectives. My observations and analysis that include off-timetable learning, suggest that using adaptable learning outcomes can also be effective in network initiation and maintenance.

5.1.1.4 ASSESSMENT

I conceptualised assessment as a material actor exerting facilitating semiotic functions driving clinical learning. However, the results suggest that assessments frequently inhibit network initiation and maintenance. This is because the most powerful predictor of student progression at the observation site was performance on a knowledge test, taken by all students once a term. More than 90% of students who fail to progress their studies, failed this test (internal assessment data). Other assessments of clinical skills, performance on clinical teams, or professionalism accounted for less than 10% of student failures. Students

accordingly diverted all possible resources to passing these knowledge tests. When students perceived clinical experience as less relevant than study in the library or at home, they left the clinical learning environment to study for knowledge-based assessments. Further research could focus on assessment methods that facilitate clinical learning network initiation and maintenance. Using learning networks to conceptualise off-timetable clinical learning therefore suggests that actors such as curriculum and assessment generated at the medical school may or may not influence off-timetable clinical learning. Furthermore, the assessment actor may generate unintended consequences such as student disengagement from certain clinical placements. Substantial modifications to assessment structures at the observation site may therefore be necessary to ensure that the assessment actor exerts action and semiotic functionality that forms facilitating relationships with the other actors in clinical learning networks.

5.1.2   MACROSCOPIC PROPERTIES OF NETWORKS

5.1.2.1 GENERAL PROPERTIES

In this set of observations, medical student clinical learning networks appear difficult and time consuming to start (taking hours), short lived (lasting minutes), delicate and prone to interruptions. These network characteristics contrast with service network characteristics of nurses, identified by Bunniss (Bunniss and Kelly, 2013), that are initiated rapidly in response to patient demand, last for as long as they are needed and are less prone to disintegrate.

5.1.2.2 LEARNING AND RELATIONSHIPS WITH OTHER NETWORKS

Networks produced opportunities to appropriate technical proficiency through practising communication and diagnostic skills. In this set of observations, networks rarely produced opportunities to appropriate clinical examination skills, or skills necessary to operate technical apparatus.

Consideration of learning as the result of learning networks suggests that learning through participation in work (or through other learning processes) is not an

inevitable consequence of student presence on hospital placements. Previous apprenticeship-style learning may have resulted in greater overlap between learning and service networks (see figure 5.1), and so generated more opportunities for participative processes as students may have experienced closer relationships with the service network actors necessary to deliver participative learning processes.

I propose that placement learning does not guarantee participative processes as the intersection between student and service network actors appeared considerably less (see figure 5.2). In observations of placement learning, other learning processes appeared to exist that did not include service network actors and at other times networks were not operational. The amount of intersection between learning network and service delivery networks was correspondingly reduced, resulting in fewer opportunities for participative processes as these depended on students, patients and service network actors all being present. The relationship between the two networks in apprenticeship and placement learning models is summarised:

Figure 5.1 Diagram of network relationships in apprenticeship learning
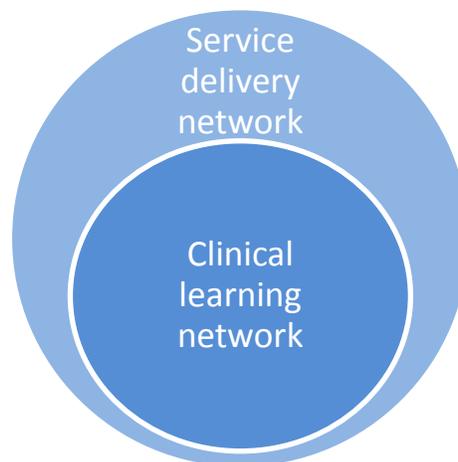
Figure 5.2 Diagram of network relationships in placement learning
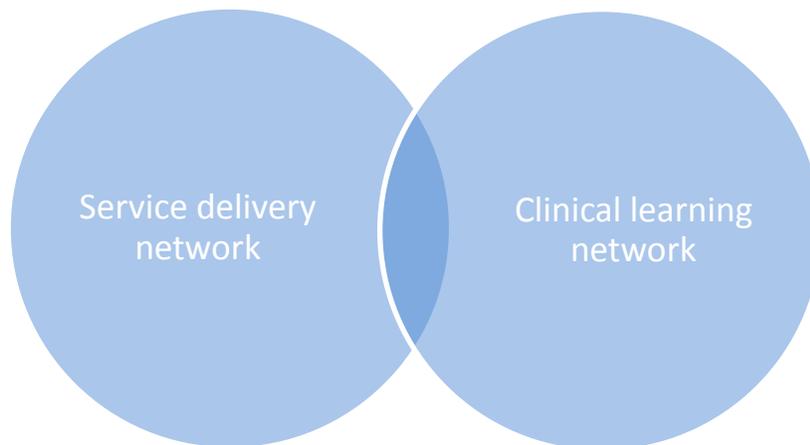
Networks appear to change over time, demonstrating three stages: initiation, maintenance and disintegration. These characteristics are the basis of further analysis.

5.2   NETWORK INITIATION: PLANNING, LOCATING AND NEGOTIATING PATIENT ACCESS

Network initiation appeared to be a key issue for clinical learning in this context. Using ANT analysis, a number of novel action functions of the student actor appeared highly visible in network initiation. These include planning how to establish a learning network, locating a suitable knowledge source (usually a patient), negotiating with a gatekeeper (usually a nurse) and then waiting for acknowledgement (semiotic recognition). However, students were subject to semiotic filtering by service delivery network actors at this and other stages. Network initiation accounted for the majority of student time and student action functions such as planning, locating and negotiating may begin to add detail to descriptions of 'unproductive time' in studies of what students do on clinical

placements (Dolmans *et al*, 2001; Worley *et al*, 2004). Successful network initiation often took several hours, as the majority of attempts were unsuccessful. Nurses played a more significant part in network initiation than anticipated. They frequently demonstrated action functions in locating and providing access to patients that facilitated the formation of student-patient relationships. This is not to suggest that the relationship between nurse and student actors always facilitated network initiation. Nurse actors also blocked access to knowledge-source actors such as patients and interrupted learning networks to fulfil service network obligations. These facilitating and inhibiting relationships often co-existed within a functioning network and I have frequently characterised nurse-student actor relationships therefore as ambiguous. These attributes and roles appear under-reported in the literature and do not seem formally recognised by the medical school at the observation site.

Senior and junior doctors maintained mostly facilitating relationships with medical students in network initiation by exerting action functions such as helping students locate and access knowledge-source actors. This often circumvented more uncertain access negotiations with nurses. However, the number of student interactions with junior doctors was less than anticipated through literature review (Becker *et al*, 1961; Sinclair, 1997). These sources indicated that students form sustained relationships with junior doctors, helping them to perform action functions associated with the service network.

Material actors had an important role in network initiation, which has not been fully recognised in previous research on medical student clinical learning. Material instruments such as technical equipment frequently inhibited network initiation for a number of reasons. Firstly, instruments such as monitors appeared to invoke unease due to semiotic projections of danger and complexity. Secondly students often lacked necessary access codes or the ability to successfully operate technical equipment such as security-coded doors or cot-sides. Finally, students often did not know where material actors necessary for network initiation were located - for example, the location of relevant offices or parts of a ward.

Objects of knowledge such as computers (containing patient locations) often formed intermediate relationships in student network initiation. That is to say computers had the potential to co-ordinate network initiation through helping students perform the action function of patient location. However, they were frequently redundant, as student actors were often not provided with the relevant passwords and access codes.

The process of network initiation appears not to contribute to technical proficiency and steps to minimise this time may improve the efficiency of off-timetable learning. Students appeared surprised at the effort required to initiate learning networks and the low rate of success. This frequently appeared to lead to students becoming demotivated and apathetic. Continued failure to initiate networks resulted in student dissociation from the service network environment to study at home or in the library. This has resource implications as clinical education costs at least £34,000 per year, per student (internal financial data from Health Education South-West). Education of students about the process of network initiation and managing expectations accordingly now forms part of routine induction at the observation site.

5.3   NETWORK MAINTENANCE:

Once initiated, learning networks were short-lived, typically lasting between five and twenty minutes. They changed rapidly, adapting to interference from the action and semiotic functions of the service network.

Learning technical proficiency appeared highly dependent on location for junior students confirming the findings of Eraut (Eraut, 2004b). Students appeared to lack the ability to retrieve or utilise knowledge learned in the pre-clinical classroom environment due to interference from the service network. In contrast to the students, senior teachers displayed an ability to filter out much of their immediate environment in order to focus on work.

The process of filtering also affected students involved in observational learning processes. Here, students often received limited semiotic recognition; appearing

to be the subject of filtering by service network actors. Students reflected this in a profound reduction in action functions associated with learning such as active listening, note-taking and asking questions. I propose that semiotic recognition of student presence is a pre-requisite for learning opportunities to arise.

5.3.1   SEMIOTIC RECOGNITION AND FILTERING

In both initiation and maintenance phases, initial and continuing recognition of student presence via semiotic signals such as verbal recognition and appropriate non-verbal signals appeared important for subsequent relationship development, network functioning and subsequent generation of learning opportunities. I term these semiotic recognition practices. All of the vignettes where networks are established demonstrated this phenomenon.

I suggest that the act of learning in these circumstances becomes largely an act of being legitimated, or recognised as a person. This process may be especially important for novice learners who may be unsure of their right to be present as learners within the service network and may therefore need more frequent semiotic acknowledgement. This personal aspect of learning may help explain why learners often became very emotional when talking about negative learning experiences as lack of appropriate semiotic acknowledgement appeared to negate themselves as people. Vignette 8 demonstrates just how far these feelings could extend.

Clinical teacher training in simple verbal and non-verbal recognition practices may result in improved network initiation and maintenance phases. Without semiotic recognition, students appeared to quickly cease action and semiotic functions associated with learning as demonstrated in vignette 5.

In network maintenance phase, filtering out the influences of the service network appeared necessary. I term this semiotic filtering. For junior students learning in busy clinical environments, this was problematic as they lacked this ability and therefore consideration of the location of junior student teaching becomes important. For example, teaching often took place at a table located on the ward with a red spotty tablecloth (see fragment in vignette 3).

Figure 5.3 Photograph showing location of informal teaching; red spotty tablecloth

In this location, students were exposed to multiple interruptions from the service network and in contrast to their teachers, did not appear to have the ability to filter these.

I presented this analysis to senior teaching staff and following this, the location of this teaching has been moved to a side room.

Experienced clinicians demonstrated high levels of semiotic filtering; to the extent that sometimes they appeared detached. I suggest that filtering is an effective adaptive strategy in work-place learning but may account in part for perceptions of empathy decline (Krupat et al, 2009; Neumann et al, 2011).

The results demonstrate that extensive semiotic filtering is necessary in order to operate within the service network and the fragment in vignette 3 demonstrates this particularly succinctly. The extent to which this filtering process occurs raises questions about how accurately students and other actors in the service network perceive their environment.

Previous ethnographies make repeated reference to the theatre (Sinclair, 1997) and artifice (Atkinson, 1997) of medical practice – implying again a filtering of

information to the extent that student and clinician reports of their environment appear to observers as a distortion or pretence. I suggest therefore, that clinicians filter not only semiotic influences such as alarm bells but also filter more complex semiotic influences such as suffering and medical error. The photograph analysis in vignette 6 highlights how an infant cardiac arrest was characterised as 'the baby being naughty'. I suggest therefore that filtering is also a necessary coping mechanism for service providers dealing with suffering on a considerable scale. The negative outcome story in vignette 3 highlights how uncomfortable a more accurate portrayal of medical practice can be if this process is not employed. On questioning service network providers, it became apparent that no supervision or counselling was offered regarding the continual exposure to this suffering. The filtering process may therefore be a useful avenue of further research regarding empathy decline, medical perception and therefore medical error.

5.3.2 LEARNING PROCESSES

Within functioning learning networks, recurring actor combinations produce certain types of learning process and these give rise to certain learning opportunities. Individual processes are summarised in their respective sections in chapter four and are summarised overleaf:

Table 5.2 Summary of learning processes.

Learning process	Student – Knowledge source actors	Learning opportunities regarding appropriation of technical proficiency
Mirroring	**Student + Patient** Students practise the work of junior doctors (clerking)	Communication skills – common. Patient examination – rare Procedural skills - rare
Participation	**Student + Service network actor + Patient related content** Students take part in the delivery of patient care	Communication skills – common Patient examination – common Procedural skills – common Patient- specific knowledge application
Teaching	**Student + Service network teacher** Students receive teaching from doctors, nurses and other knowledge-source actors.	Communication skills - common Patient examination – rare with seniors, common with juniors Procedural skills – rare with seniors, common with juniors
Observing	**Student + Service network actor** Students observe service provision	Communication skills - rare Patient examination - rare Procedural skills – rare Students appear disengaged from knowledge appropriation processes
Dissociative	**Student + Non service network knowledge-source** Students leave clinical environment during timetabled 'SDL' activity to learn from objects of knowledge.	Communication skills – Clerking commonly practised via skype with friends and relatives Examination skills – Commonly practised on friends and relatives De-contextualised, general medical knowledge appropriation for assessments

Observations show that different learning processes and their associated learning opportunities arose serendipitously in off-timetable learning at the observation site. Articulation of the necessary actors, functions and relationships presents the possibility of being able to plan for these processes to occur more systematically. The following discussion of individual learning processes uses study data to highlight some possibilities for educational planning and interventions made at the study site.

5.3.2.1 MIRRORING

The mirroring learning process is described, analysed and summarised in vignettes 1 and 2.

Mirroring was dependent on student access to patients to perform 'clerking' procedures. However, access was problematic and time-consuming.   Generating lists of suitable teaching patients or other more systematic approaches to student access may be worth consideration. Clerking procedures followed a single structure, based around making a diagnosis on an acutely ill patient and students did not deviate from this protocol. However, the diagnosis was normally established before the students clerked the patient. Students rarely accessed patient knowledge about their condition, did not ask about the effects of illness, or how the patient's quality of life could be improved. There seems an opportunity to utilise patient knowledge source actors in alternative ways to that of the clerking procedure and this may be a useful avenue of further research. Students rarely received support or guidance in performing this procedure, which they carried out either alone or sometimes in pairs.

Clinical skills tutors were employed at the observation site to deliver clerking training on simulated patients in clinical skills laboratories. Based on this particular set of observations, it may be useful to consider how these tutors could also be used to support student learning from real patients in the hospital.   Designing different clerking procedures that cover an expanded range of diagnostic possibilities and intended outcomes from the clerking procedure may expand the opportunities for learning. Furthermore, clinical students in different years may benefit from different types of clerking formats with patients. For example, junior students may benefit from seeing many patients to learn the fundamentals of medical conditions. However, senior students may benefit from seeing the same patient on several occasions. This may help students learn about how medical conditions change over time. It may also help students to begin to comprehend the long-term relationships between patient and clinician that constitute much of clinical practice. In this way, clerking may become one of a number of mirroring

processes. In this particular set of observations, I only observed clerking and did not observe other questioning approaches. The reasons why only one process has been used in highly variable contexts may be an interesting area of further research.

5.3.2.2 PARTICIPATIVE PROCESSES

Participative processes occurred occasionally in off-timetable learning. However, this study has focussed on students in their first year of clinical learning and it is possible that participative processes become more common as students progress through the clinical years. Further work to examine this may be helpful. Participative processes generated particularly rich learning opportunities such as practising communication, diagnostic and examination skills. Participative processes may therefore represent an ideal in clinical learning and several authors emphasise its importance (Dolmans *et al*, 2002a; Dornan *et al*, 2007; Hoffman and Donaldson, 2004). This study adds to this body of work by articulating some of the necessary actors, functions and relationships for this type of learning to occur. Study findings suggest that learning through guided participation in work did not happen inevitably as a result of clinical experience. That is to say that the participative process was not always a feature of the learning networks observed. For much of student time, learning networks were not operational but were in initiation phases. In other instances, networks were operational but students appeared not to contribute to work. In other instances, non-clinical learning networks featured student dissociation from the work environment. Use of network analysis may therefore contribute to understanding different mechanisms of learning when students are not undertaking guided participation. Participative processes did not happen inevitably through clinical placements. However, an understanding of the actors, functions and relationships involved may be useful in planning so that this process may occur more frequently. Using study information, I introduced an intervention that aimed to increase the frequency of learning networks containing participative processes. Students

arranged sessions with specified junior doctors during off-timetable learning periods. The process was organised through social media and was quality assured by the medical school, which provided educational training, evaluation and certification for the junior doctors taking part. Students then received patient-oriented teaching from junior doctors. Through this process, the intervention served to facilitate social ties between students and junior doctors as the same group of students returned repeatedly to the same junior doctor. Over a period of weeks, students would increasingly stay with the doctor after the teaching had finished, to help with their day-to-day duties and in this way participated more frequently in work under the guidance of a facilitator. The extent to which medical schools are responsible for support and quality assurance of this off-timetable learning may be a useful avenue of further research. This intervention demonstrates how understanding participation as a learning process, formed of certain actors and relationships, can lead to curricular interventions that can increase its frequency.

5.3.2.3 TEACHING PROCESSES

Students spent little time receiving teaching during off-timetable learning and teaching processes did not represent the primary focus of the study. Review of the literature uncovered one teaching model known as the one minute preceptor model (Irby and Wilkerson, 2008), but I did not observe this being used. Instead, senior teachers commonly used a question and answer format that tested factual recall. This contrasted with junior doctor teaching that was more concerned with demonstrating and discussing practical skills. As discussed, students frequently had problems in finding patients to clerk and when this happened, teacher actors used hypothetical cases or tested recall of textbook information. The presence of a patient knowledge-source actor (patients or their notes), transformed teaching into case-specific discussions where students applied relevant knowledge to specific cases and were frequently exposed to the divergence between text-book accounts of medicine and clinical practice.

5.3.2.4 OBSERVING PROCESSES

Observing processes involved weak or partial connections (Fenwick, 2011) between actors.

This adapted ANT analysis predicts that when relationships between actors are weak, networks are correspondingly diminished and learning opportunities reduced. Observations appeared to confirm this. Students commonly observed the service delivery network for hours without normal semiotic acknowledgement of their presence (such as verbal or non-verbal signs). When this occurred, it was difficult to observe action functions associated with functional learning networks, such as note taking, questioning or active listening.

I have previously argued that service network actors need to exert considerable semiotic filtering in order to perform the actions functions associated with work delivery. Often this occurred to such an extent that the student actor did not receive semiotic recognition of their presence.

Without these recognition practices, students often exerted semiotic functions such as appearing lethargic, demotivated and uncomfortable. Furthermore, they did not show action functions normally associated with learning.

I suggest therefore that semiotic recognition practices may form the microstructure of legitimate peripheral participation. Semiotic recognition may therefore represent the mechanism for initiating facilitating relationships between student and teacher actors.

An intervention in these circumstances might involve further teaching to service network providers about semiotic recognition practices. This may increase relationship and therefore network strength and subsequent learning opportunities.

5.3.3   OUTCOMES OF FUNCTIONAL LEARNING NETWORKS – LEARNING OPPORTUNITIES

Opportunities to practise communication skills by clerking patients were commonplace through mirroring processes. However, opportunities to examine patients and practise procedural skills were far less frequently observed. This was

because networks containing participative processes that generated these opportunities were correspondingly infrequent.

Despite the difficulties relating to patient access, the vast majority of students at the observation site are graduated as technically competent doctors and enjoy a reputation nationally as some of the best prepared for practice (Goldacre, Lambert and Svirko, 2014). However, the same study also finds that in the UK, approximately 50% of doctors do not feel their medical training prepares them adequately for practice.

It may be that some doctors do qualify therefore without the necessary technical proficiency skills but with an ability to pass knowledge tests. Alternatively, students at the observation site may have accessed the necessary technical proficiency skills in other ways: in clinical skills laboratories or when present on other wards and at other times when they were not being observed. Analysis of study results indicates that there may be considerable potential for clinical placements to contribute more systematically and efficiently to technical proficiency through using network principles to plan for specific technical proficiency outcomes.

5.4   NETWORK DISINTEGRATION AND STUDENT DISSOCIATION

The most common cause of network disintegration was interference from the service delivery network. Semiotic functions (such as the cardiac arrest bleep in vignette 4) brought networks to a sudden halt. Action functions such as ward rounds, patient visiting, nursing activity, cleaning and diagnostic procedures all took priority over student network maintenance and led to rapid network disintegration.

Material actors also played a part in network disintegration. Students appeared unfamiliar with the location of essential material instruments necessary to maintain their networks, such as dressings and other medical equipment. This was compounded by short clinical attachments that give students little time to become familiar with their surroundings. Students also appeared to lack the practical skills to deploy many material instruments necessary for network maintenance, resulting

in premature network disintegration. For example, operating patient beds and cot-sides, handling notes and negotiating technical equipment such as monitors appeared constantly problematic. When networks disintegrate, students often immediately attempted to initiate new ones but frequently did not know how to operate instruments that would facilitate this, such as using the bleep system to contact junior doctors.

My observations appear to suggest that repeated failure initiating networks or repeated premature network disintegration may contribute to students adopting characteristics such as detachment from learning when present (for example, vignette 5 and vignette 3 fragment). Other vignettes suggest that initiation and premature disintegration issues can result in students opting to study temporarily in the library or at home during timetabled clinical learning time (vignettes 6 and 7). In vignette 8, the student appears to have concluded that in general his time is spent more effectively studying at home and has dissociated where possible from the programme.

A spectrum of dissociative practices appears possible, ranging from students appearing dislocated and detached when present, to temporary dissociation from the clinical environment and finally to more-or-less permanent dissociation from the clinical programme.

Students commented that fellow students who adopted a dissociative approach to clinical learning, did not fare any worse in high stakes knowledge-based summative assessments. Paradoxically therefore, the assessment actor often appeared to inhibit clinical learning network relationships by exerting semiotic functions of fear of failing knowledge tests.

Further work clarifying the extent of dissociation would seem useful. Identification of students who have dissociated from clinical learning placements can provide an opportunity to give added support to these individuals and in the process, may reveal useful information about why individuals who have worked hard to gain a place on a medical course should choose to dissociate from the clinical placements.

Network disintegration represents the final stage of the clinical learning cycle that consists of network initiation, maintenance and disintegration. The network components and their relationships have been described and a mechanism for accounting for how these relationships change over time has been outlined. This process has highlighted a number of interventions to facilitate network initiation and maintenance and to reduce network disintegration. These interventions are summarised overleaf.

Table 5.3 Summary of possible interventions related to stages of clinical learning cycle. (Implemented changes italicised)

		Stage	Intervention

Clinical learning cycle	Network Initiation	**Planning**	• *Specific off-timetable curriculum guidance from medical school providing;*
			   ◦ *Outcomes capable of adapting to different clinical cases.*
			   ◦ *Planning specific learning processes.*

		Locating	• Improved access to software systems • *Access to wireless networks* • *Access cards to all medical areas*
		Negotiating	• Involvement of nurses in teacher training • *Practice for students in talking to service network actors*
	Learning network	**Network maintenance**	• *Extended clinical attachments* • *Extended student induction including introduction to material actors in clinical learning* • Teacher training emphasising semiotic recognition practices • *Delivering teaching in locations where service network disruption is minimised.* • *Providing protected time to deliver specific learning processes*
	Dissociation	**Network disintegration**	• Student introduction to clinical learning cycle and inevitability of network failure • Evaluating and interview of students who dissociate • Educational interventions to service providers regarding role of students

PART 2 WIDER IMPLICATIONS

5.5 IMPLICATIONS FOR RESEARCH

5.5.1 METHODOLOGY

I have developed a bespoke methodology and analytic framework to apply a socio-material theory to the investigation of clinical learning. Articulation of methods and analysis allows replication of the work and provides a rationale explaining how conclusions are made.

Operationalised in this way, ANT appears complicated but useful in describing the wide range of disparate actors and relationships involved in complex systems such as clinical work-place learning.

In order to articulate the findings, I have devised a vocabulary to describe new actors, properties, relationships, learning processes and network stages that become visible at detailed resolution. Collectively, this design strategy provides the requisite tools enabling precise description and analysis of both the human and material factors that appear necessary for clinical learning. However, the approach may be off-putting as there are a number of necessary new terms and concepts. Subsequent presentation, critique and use of these approaches by other researchers may begin to provide feedback on their utility.

Nevertheless, the approach reveals several new areas for research. These have been addressed in relevant sections and are summarised in table 5.4:

Table 5.4 Summary of further research opportunities

Analytic concept	Resulting further research opportunities
Network components	
Material actors	• Role of instruments (monitors, access mechanisms) • Role of knowledge objects (computers, smartphones) • Material properties of wards (ward layout) • Reappraisal of the roles of curriculum and assessment in placement learning
Human actors	• Roles of human actors under-reported in literature (nurses, managers, junior doctors) • Elaboration under-reported properties of known actors (projections of competence by student actors)
Human and material actors	• The role of placement length on student relationships with human and material actors
Semiotic acknowledgement	• Further research on the role of semiotic acknowledgement and student learning
Semiotic filtering	• Further research on the role of filtering in issues such as medical student perception
Learning processes	• Further elaboration of the relevant actors, functions, relationships and outcomes. • Investigating the systematic use of learning processes in curriculum design • Generation of alternative 'clerking' procedures to generate differing learning outcomes. • Investigation of how much the participation process is evident in different clinical years • Investigating the role of the medical school in planning for certain learning processes in off timetable learning
Network change over time	
Initiation	• Further research outlining the roles of planning, locating and negotiating
Network maintenance	• Further research on the role of interruptions of service network providers • Further research on issues of medical student power in clinical environment
Network disintegration	• Including quantification of dissociation in students, economic implications and reasons for dissociation.

The vocabulary of actors, functions and relationships was particularly useful in describing 'micro-learning' interactions. I suggest a lack of a systematic micro-learning framework to describe relationships between human and material actors has led to an emphasis on broader notions of human actor interaction that can overlook the role of material actors and phenomena that occur within individual learning interactions.

Further research on 'micro-learning' may usefully investigate different clinical environments involving different years of students.

5.6   IMPLICATIONS FOR LEARNING

In this study I have not measured or quantified learning; rather, I have observed how learning is done, the opportunities that seem to arise and resultant action functions that may correlate with learning activity.

Where networks arose, learning opportunities seemed plentiful and action functions associated with learning were often encountered.

Where there were weaker networks containing partial relationships, such as networks containing observational processes, opportunities were still plentiful but action functions associated with learning seemed reduced.

When networks were not in operation, for example in network initiation, no discernible learning opportunities seemed apparent regarding technical proficiency and no action functions associated with learning were apparent.

It is possible to suggest therefore, that the networks produced learning. Learning becomes firstly a social process involving humans (that are particularly sensitive to semiotic recognition practices). Learning also becomes secondly, a product of varying but predictable patterns of interactions involving human and material actors.

Learning opportunities appeared to vary with the nature of individual learning networks. It was difficult to discern guiding principles underlying this learning. This picture of learning opportunities as variable and as the product of networks contrasts with notions of single overarching principles or theories of learning

espoused by the medical school and in general policy documents on clinical learning in medical education.

As previously discussed, the role of human actors in clinical learning has been interrogated in depth. The role of material actors has received less attention. A limited number of material actors have been identified in this study and a classification system suggested. Extension of research to other clinical departments involving different technical equipment and material actors may add strength to the findings. In addition, many other highly technical undergraduate work-based learning environments exist, such as engineering, electronics and computing. Further research on the role of human-material relations in these circumstances may be useful.

Related to discussions concerning how clinical students learn, are discussions regarding how to plan for clinical learning. I have suggested that learning occurs as a product of learning networks and have outlined a set of network premises. It may be possible to use these premises to plan for and improve learning and I have outlined several changes brought about in a curriculum committee through using network premises.

The roles of curriculum and assessment have been examined and the results indicate that in this context their roles were either diminished or counter-productive. Conceptualising clinical learning through Actor-Networks may contribute to educational planning by attending to the relationships not only between the curriculum and assessment actors, but also by attending to the array of other relevant actors that are outlined in this study.

5.7 IMPLICATIONS FOR PERSONAL PRACTICE

5.7.1 INTERVENTIONS AS A RESULT OF RESEARCH

5.7.1.1 PROCESS OF IMPLEMENTING INTERVENTIONS

This is a professional doctorate and I have tried to translate study findings into program improvements. This has been facilitated by having a relatively senior role at the school (although the disadvantages are discussed at length in chapter 3). I considered the process of how to translate findings into program changes and concluded that a formal structure within the medical school was needed to implement changes.

As discussed, I convened a curriculum group (The Curriculum Innovation Group) with student, patient, hospital manager, clinical teacher and curriculum designer input. I followed the work of Engestrom (Engeström, 1993) by involving all the relevant human actors I had observed in clinical learning networks. In contrast to Engestrom's group, I was able to facilitate considerable change. I propose that my dual role as researcher and manager may have contributed to this. I also suggest that the group was part of the formal committee structure of the school, unlike Engestrom's, and had institutional power as a result.

Despite access to senior hospital and medical school managers via the curriculum innovation group, it was often difficult to persuade them to support proposed changes. I found two approaches to initiating change successful. Firstly, presentation of any changes as cost neutral, with detailed accounting data. Secondly, for more ambitious changes, senior managers preferred small-scale pilot schemes with subsequent upscaling, rather than large scale immediate curriculum change. Finally, the novel analytic method and terminology employed in the study produced results that did not always fit with conventional educational classifications and this led to issues with communicating research findings to senior hospital and medical school personnel. A particular personal learning point from this work has therefore been learning to clearly and effectively communicate study findings.

5.8 STRENGTHS AND WEAKNESSES

5.8.1 DESIGN AND METHODS

The research question examines how clinical learning takes place and this has been addressed through direct observation of the phenomenon.

Observation of junior clinical students and their teachers by a senior member of staff influences their behaviour and I have discussed the ways in which this was minimised. I was surprised at the candour of student interviews – some electing to tell me extremely sensitive stories of learning (see vignette 8). These observations suggest that students were relatively comfortable with my presence. The advent of reality TV and changed relationships between learner and teacher may account in part for this. It is possible that at times students used 'I'm going to the library' to express their discomfort with my presence but I could not verify this. I appeared to exert more effect on clinical teachers. I observed teacher irritation on several occasions when teaching did not occur as planned, and suspect that despite attempts to assure the teachers that the observations were concerned with learning process rather than teacher evaluation, understandable attempts were made by the department to present teaching in the best light.

I observed students only in their first year of clinical studies, when all the social and material obstacles are fully visible. Learning in later years may be different and this study does not observe student learning in the senior years (with the exception of vignette 2). Many previous studies have observed students in all three clinical years, as the structure of clinical training does not often change significantly throughout the clinical years (Becker *et al*, 1961; Sinclair, 1997). The first clinical year may be worthy of further attention and a number of interventions appropriate because of its boundary role between pre-clinical classroom learning and clinical work-based learning.

5.8.2 ANALYSIS

Critiques of contemporary sociocultural and socio-material learning theories frequently suggest that whilst theoretically attractive, they are difficult to operationalise into a set of empirical methods or analytic tools (Morris, 2012a). In this study, I use several analytic methods congruent with ANT, to derive a bespoke analytic approach capable of analysing the mechanisms of learning interactions. This focussed analysis has generated high-resolution accounts of student learning that articulate the interactions between actors of different types and may provide an interpretive framework for some of the more generalised sociocultural interpretations of learning that have been difficult to operationalise at the level of learning interactions. In addition, the analysis suggests that wider, more generalised notions of learning may not be applicable in all circumstances and when present, are composed of a microstructure.

However, this approach has perhaps generated accounts of learning that appear different to conventional, wider socio-cultural analysis. Unlike many other ANT studies, there is no continuous narrative blending literature, method, results and conclusions (Mol, 2002). In addition, the analysis reduces many complex phenomena (such as assessment and curriculum), into certain types of actors with certain functions and relationship properties and this may seem simplistic and iconoclastic. In rebuttal, I suggest that ANT sets out to question established hierarchies that can inhibit new ways of thinking. By placing assessment alongside hospital notes and nurses, this study has sought to offer a fresh and integrated way of depicting clinical learning.

GLOSSARY

Acid-base balance	The balance of acids and alkalis in bodily fluids – in **sepsis**, bodily fluids can become acidic.
AHPs	Allied Healthcare Professionals (Physiotherapists, radiographers and other NHS professionals)
Boggy swelling	Clinical finding that can indicate an underlying fracture of the skull
Bag and mask	Equipment used to do the work of the lungs at a cardiac arrest
CSF	Cerebro-spinal fluid: A fluid that surrounds the brain and spinal cord.
Developmental milestone	Stage of development in a baby (for example the age at which most babies can walk, talk etc)
Drip delivering inotropes	A bag of fluid containing a drug to stimulate the heart. This is delivered into the bloodstream via a plastic tube inserted into the baby's veins.
ED	Emergency Department (also known as A&E – Accident and Emergency)
Fitting	Having an epileptic fit
Histopathologist	Doctor who is responsible for looking (often microscopically) at specimens taken from patients to see if cancer or other disease is present.
IO line	Interosseous line; when a vein cannot be found to site a plastic tube (drip), the tube is placed directly into a bone. This allows fluids and drugs to be administered rapidly. Important in sepsis where fluids can deplete rapidly.

Obs sheet	Observation sheet: A sheet summarising essential patient data (blood pressure, pulse, oxygen levels etc)
Paediatric cardiac arrest	A child's heart stops beating – a medical emergency.
PAU	Paediatric Admissions Unit – A dedicated paediatric ward located within A&E (also called ED – Emergency Department)
Patient location sheet	Sheet summarising where patients are located and their main diagnosis. Used by junior doctors only and sometimes distributed to students.
Quadriplegic	Being unable to use effectively the arms or legs
Sat monitor	Saturation monitor: machine that measures how much oxygen is being carried in the blood. This is done by attaching a probe to the patient. In young children this often becomes dislodged, resulting in an alarm sounding.
Sepsis	Severe infection that spreads from an initial localised site to infect the body more generally.
SHO	Senior House Officer: a junior hospital doctor.
SSU	Self- selected Study Unit: A part of the course that the student chooses themselves lasting from 1-3 weeks.
UTI	Urinary tract infection (cystitis)
Ventilator	Machine used to do the work of the lungs.

APPENDIX 1 – ETHICAL APPROVAL

UNIVERSITY OF EXETER | MEDICAL SCHOOL

University of Exeter Medical School
Research Ethics Committee

Certificate of Ethical Approval

Research Institute/Centre: Clinical Education/Institute of Education, University of London

Title of Project: What is a clinical curriculum in a twenty first century medical school

Name(s) of Project Research Team member(s): Dr Alex Harding

Project Contact Point: Dr Alex Harding

This project has been approved for the period

From: May 2013

To: August 2014

University of Exeter Medical School
Research Ethics Committee approval reference: May13/B/019

Signature

Date: 21st May 2013

Name of Chair
Peta Foxall, PhD

Your attention is drawn of the attached paper "Guidance for Researchers when Ethics Committee approval is given", which reminds the researcher of information that needs to be observed when Ethics Committee approval is given.

Application Reference Number 13/04/019

APPENDIX 2 – CONSENT FORM

UEMS REC 13/04/019   <u>**CONSENT FORM**</u>   *V3 12-05-13*

What is a clinical curriculum in the twenty first century?

I have read the Information Sheet Version Number 3 Dated 12-05-13 concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.
I know that:

1.   my participation in the project is entirely voluntary;   Y/N

2.   I am free to withdraw from the project at any time without any   Y/N
     disadvantage;

3.   The data will be retained in secure storage;   Y/N

4.   There will be no formal interview involved   Y/N

5.   I understand the risks involved   Y/N

6.   I will receive no payment or prizes for participating   Y/N

7.   The results of the project may be published but my anonymity will   Y/N
     be preserved.

I agree to take part in this project.

....   ……………………..   ....
(Printed name of participant)   (Signature of participant)   (Date)

....   ……………………..   ....
(Printed name of researcher)   (Signature of researcher)   (Date)

APPENDIX 3 - INFORMATION SHEET

Royal Devon and Exeter **NHS**
NHS Foundation Trust

UNIVERSITY OF EXETER | MEDICAL SCHOOL

Information Sheet

UEMS REC 13/04/019   V3 12-05-2013

What is a clinical curriculum in the twenty first century?

_____

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.
If you decide to participate I thank you. If you decide not to take part there will be no disadvantage to you of any kind and I thank you for considering this request.

What is the purpose of the study?
This study aims to describe what its like to be a medical student learning on the wards. A better understanding of this process may help to improve how clinical learning is organised. I hope to observe medical students learning and then ask then questions about the learning where appropriate. The study is not about the quality of the teaching, or how good medical students are.

Why have I been invited to participate?
You have been asked to participate in this study as you are a clinical medical student on the paediatric wards during the time that this study is taking place. Other medical students have been asked to participate. There are no other reasons why you in particular have been asked to participate.

Do I have to take part?
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?
I am aiming to observe how you learn during your time on the ward. This may be on organised teaching activities such as clinics and ward rounds. It may also be when you are learning on your own (clerking patients or shadowing junior doctors or discussing cases over a coffee). I will be observing only whilst the learning is taking place. I will record this information on a mini-laptop computer (a netbook). All computers are password protected and encryption software will be used to transfer data between computers.

Despite being a member of the medical school team, I have no influence over any marks or assessments carried out on the ward. However, as a clinician I do have an obligation to act if patient safety may be affected.

Risks
Through taking part in this study it is possible that you will experience both good and bad learning experiences, which I will observe. Where this takes place I hope to act is a suitably sensitive manner.

What are the possible benefits of taking part?
Through taking part in this study it is possible that some of the ideas that emerge may subsequently influence how learning is delivered at Peninsula Medical School and UEMS. Several improvements to your course have already been made as a direct result of initial work. These include an increase in time devoted to introductory sessions at the beginning of all attachments, and increasing the time of surgical and psychiatric rotations from one to three weeks.
More generally I hope that when the study is completed it will play a small part in influencing how clinical learning is delivered in other medical schools.

Will what I say in this study be kept confidential?
The information that you tell me will be kept confidential unless patient safety, or the safety of others is at risk. Once collected the data will be stored in a way that ensures your anonymity. For example you will be given a participant number rather that your name. Data will be kept on one of two password protected laptop computers. Transfer of data between these computers will be carried out using an encrypted memory stick. If data is published, you will be referred to by your number and the dates of your participation will be withheld.
In line with research guidelines, the data will be kept for five years and then destroyed.

What should I do if I want to take part?
If you would like to take part I will ask you to sign a consent form. You can withdraw from the study at any point.

What will happen to the results of the research study?
This study is part of a Doctoral Degree sponsored by the University of London. I will aim to publish this study in a peer-reviewed journal. If you would like to see a copy of the work please let me know your e mail address and I will send you a copy.

Who is organising and funding the research?
This research is being carried out under the joint guidance of The Institute of Education at the University of London and The University of Exeter Medical School.

Who has reviewed the study?
The research design has been peer reviewed at The Institute of Education in London and at The University of Exeter medical School. The research has been approved by the Ethics Committees at The University of Exeter Medical School, The University of London and The Royal Devon and Exeter NHS Foundation Trust.

Contact for Further Information
For further information about this study please contact
Dr Alex Harding 07811 138 703 alexander.harding@pms.ac.uk

If you have concerns or complaints about this research please contact the Research and Development Department of the RD&E on rde-tr.research@nhs.net.
You can also contact Dr Peta Foxall, PhD, Chair of UEMS Research Ethics committee on
P.J.Foxall@exeter.ac.uk

**This project has been reviewed and approved by the
University of Exeter Medical School Research Ethics Committee**

With many thanks for your time

Alex Harding

Dr Alex Harding MEd FRCGP
Lead Researcher

V3 – 12-05-2013

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