

The Knowledge Growth and Clinical Decision Making of Student and Experienced Midwives: A Comparative Study

NERIDA C. AMBLER

The Knowledge Growth and Clinical Decision Making of Student and Experienced Midwives: A Comparative Study

Nerida C. Ambler

RN, RM, DIP. (Teach) Nursing, B. Ed, MN (thesis).

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Declaration

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ABSTRACT

A midwife is a professional who assists women to birth and is legally accountable within her scope of practice. Midwives are faced with potential clinical problems at every birth they attend and their ability to deal with these problems is essential in safe and effective midwifery practice.

The aim of this study was to examine the knowledge growth and clinical decision making of student and experienced midwives performing a normal birth task. In order to understand how students' knowledge develops compared with midwives' knowledge the study investigated the following questions:

What is the nature of the differences between midwifery students (after their first and twentieth birth) and experienced midwives in their use of declarative, procedural and conditional knowledge when making clinical decisions during a normal birth?

What is the nature of midwifery students' discipline specific knowledge after their first and twentieth birth when making clinical practice decisions?

What is the nature of experienced midwives' discipline specific knowledge?

This qualitative study used the protocol analysis method. There were two groups in the study. In group one the student midwives (N=15), were interviewed on two separate occasions; after their first birth, at the beginning of a Graduate Diploma of Midwifery program and again after the twentieth birth, at the end. Group two were the experienced midwives (N=12) working in a delivery suite.

Retrospective data was collected using a structured interview designed to mirror the chronology of the birth process. The data was categorised using a coding scheme constructed from the research literature that links the structure of knowledge and the development of expertise (Boshuizen and Schmidt, 1992; Cantwell, 2004; Ericsson and Simon, 1993), with the *National Competency Standards for the Midwife* (ANMC, 2006), and declarative, procedural and condition knowledge types (Alexander and Judy, 1988). A series of Wilcoxon Signed Ranks Tests on the students' data (after their first and twentieth birth) and a series of Mann-Whitney Tests on the students' data (after their twentieth birth) and experienced midwives' data to examine all group differences across the coding categories.

The results demonstrated that the difference between students and experienced midwives was in the quality and structure of their declarative, procedural and conditional knowledge. Students (after the first birth) displayed knowledge gaps as a result of their limited prior knowledge and practice experiences and minimal engagement with the complexities of the birth task. The thinking and knowledge development in students' after their twentieth birth was similar to that of the midwives. The students' and midwives' declarative, procedural and conditional knowledge was linked to the complexities of the task. This enabled quick and more accurate identification of data cues and expertise in birthing. The change in the quality of knowledge was evident in the transition from students' first to their twentieth birth however the midwives' knowledge was found to be structurally more sophisticated.

In the qualitative analysis the differences between the structure and quality of each groups' knowledge were examined using the Structure of the Observed Learning Outcome taxonomy (Biggs and Collis, 1892). The results indicated students' knowledge after their first birth reflected a uni-structural and beginnings of a multi-structural level of understanding. With increased depth and breadth to their knowledge and experiences by the twentieth birth the students' knowledge had reached the relational level of understanding and the first cognitive shift in thinking. The midwives knowledge and experiences were at the extended abstract level of understanding.

The students' (after their first birth) loosely structured knowledge indicated gaps that limited their decision making ability but by the twentieth birth knowledge and experiences had transformed demonstrating a qualitative shift in thinking. The integration of their declarative and procedural knowledge had formed conditional knowledge. On the other hand the experienced midwives had a well-structured discipline specific knowledge base linked to sophisticated decision making abilities.

In the discipline of midwifery the cognitive and metacognitive knowledge are the scaffolds inherent in knowledge development and decision making. Implications of the findings are important for midwifery education and the professional development of midwives.

CHAPTER ONE: INTRODUCTION TO THE STUDY

A midwife is a professional who assists woman to birth. The interdependent care relationship midwives have with women is unique to this occupation. Midwives are legally responsible and accountable for actions within their scope of practice (Freeman, 2003; Thompson and Dowding, 2002).

She is neither a nurse nor a doctor – she is a professional trained to work with a large amount of independence and responsibility, calling on the general practitioner or obstetrician when the pregnancy or labour looks as if it is getting into difficulty.

(Boyd and Sellers, 1982 p.123).

Researchers claim midwifery practice is a discipline based on art and science (Bennett and Brown, 1999; Hunter, 2007; Kelly, 1997; Oakley, 1989; and Siddiqui, 1994 and 2005). The art of midwifery signifies the personal and instinctive behaviours of care. The science is based on sound theoretical and scientific midwifery knowledge.

Midwifery practice is recognised as independent of nursing (Glover, 1999a; Heartfield, 2006; Kelly, 1997; McCaughan, 2002; McCrea, Thompson, Carswell, and Whittington, 1994). Nursing practice is identified with the sickness role. Formal nursing practice care is focused on the person's hygiene, and its influence on their ability in recovery from infection, inflicted wounds, surgery and illnesses (Benner, 2004; Meleis, 1985; Nightingale, 1860; Price and Price 1993). The care of the usually young and healthy childbearing woman is what differentiates midwifery from nursing practice (Glover, 1999a; Kelly, 1997; Marchant, 2005; Mok and Stevens, 2005; Kitzinger, 1998). Both nursing and midwifery disciplines have a congruence of shared professional competency standards, theoretical and scientific knowledge, and the core concept of caring (Heartfield, 2006; Hunter, 2007).

The goal of midwifery practice is committed care of the childbearing woman primarily in the context of the normal paradigm. This is woman-centred care and involves a specific physical and psychological cluster of midwifery skills (Beischer and Mackay 1988; Bennett and Brown, 1999; May and Mahlmiester, 1990). In the context of caring, midwives and medical clinicians collaborate. Medical care extends through the normal paradigm and when medical conditions arise with woman or the progression of labour is in difficulty, a resolution is dependent on medical intervention (Beischer and Mackay 1988; Bennett and Brown, 1999; Boyd and Sellers, 1982; May and Mahlmiester, 1990; Olds, London and Ladewig, 1980).

The disciplines of midwifery, nursing and medicine are independent. Each draws on a collective knowledge with complementary roles in managing woman's care whilst independently maintaining an orientation to their individual professions (McCaughan, 2002; Weaver, Clark and Vernon, 2005).

Fundamental to professional midwifery practice is decision making; and effective decision making involves the art and science of midwifery knowledge (Sullivan, 2005). The essential element when reasoning clinical care decisions occurs in partnership with women (Freeman, 2003; Kelly, 1997; Marchant, 2005; Price, 1995).

Midwifery practice, while in existence for a long while, is new as a formal discipline in its own right, with limited research on its practice and knowledge compared to the practices of the other health professions. Basic information about midwifery knowledge and practice are in the practice competency standards set out by the respective nursing and midwifery regulatory authorities. This chapter outlines the midwifery practice, education and research presently available.

The Chapter is in four parts. The first part introduces a brief history of Australian midwifery education from 1862 to the present including an overview of the National Competency Standards for the Midwife. The second part highlights the midwifery practice research literature and the third part examines other health professionals' clinical decision making practice research literature and knowledge development. The final part of the chapter introduces the aims of the study, which is followed by an overview of the thesis.

Midwifery Education

Formal midwifery training in Australia began in 1862 at The Royal Women's Hospital, Melbourne. The first Australian curriculum originated from the traditional Florence Nightingale School in the United Kingdom (Barclay, 1989; Barclay 2007; Love, 1979; New South Wales (NSW) Midwives Association, 1984). In NSW the bill to regulate midwives' practice was first introduced in 1895 and approved by the NSW State Legislative Assembly in December 1924, some 29 years later. The bill regulated the midwifery workforce and the professional identity of midwives.

In 1900 the Australian Trained Nurses Association (ANTA) and its sub-branch the Midwifery Nurses Auxiliary, formed the professional nursing board to accredit and regulate all nurse and midwifery education programs; and completing the general nurse training program was

the prerequisite to the midwifery training program. Midwifery training was designed as “learn on the job” while working in a maternity hospital and involved completing an oral examination before a board of examiners (NSW Midwives Association, 1984). These hospital based programs typified the apprenticeship approach to learning.

In the apprenticeship learning mode an individual’s knowledge base is structured and developed through practice. In this model there is also a close relationship between knowledge development and experience called intuitive practice (Davis, 1995; Lane, 2002; Young, 1987). The concept of intuitive practice places an emphasis on understanding a situation at an unconscious level of cognition, described as intuitive grasp, where common meanings about practice are developed and understood in diverse clinical situations (Benner, 1984). The learning in this model was individual and often described as the ‘art’ of midwifery (Klein, 2003; Thompson, 1999).

Midwives and nurses in clinical practice situations often relied on instinct and intuition when they suspected something was wrong and acted accordingly (Pyles and Stern, 1983; Schrader and Fisher, 1987; Shaw, 2001; Tanner, Benner, Chelsa, and Gordon, 1993; Young, 1987). They monitored the situation as a whole rather than using a logical reasoning process (Benner, 1984; Benner and Tanner, 1987). Intuitive practice has been identified as a sophisticated synthesis of clinical and analytical knowledge, and is linked to years of experience in midwifery practice (Benner, 1984; Shaw, 2001).

Experience in clinical practice does not equate to expertise (English, 1993). Benner and Tanner (1987) maintain that because intuition appears to lack clarity and coherence of thinking and since it is not measurable and does not have a readily defined framework for learning, this type of experience cannot be taught (Easen and Wilcockson, 1996; Peden-McAlpine, 2000). Price and Price (1993) explained that midwifery knowledge grows by active reflection on practice linked to theoretical knowledge, and the intuitive practice model is one approach to the development of expertise.

By the 1980s the traditional undergraduate apprenticeship learning model for nurses and midwives changed to align with other health professionals’ models of learning. In 1985 nursing education moved from the hospital based apprenticeship model to the tertiary sector. The midwifery profession argued for equal status with nursing and by 1995 the first postgraduate tertiary program (in partnership with health sector hospitals) began (Australian

Health Workforce Advisory Committee, 2002; Brodie and Barclay, 2001; Glover, 1991; Leap and Barclay, 2002; Leap, Barclay, Nagy, Sheehan, Brodie and Tracy, 2002).

In 1997 the Commonwealth Government commissioned a National Review of Specialist Nurse Education, and highlighted deficiencies in midwifery education. The review examined the quality and quantity of current specialist nurse education programs linked to specialist nursing practice within the Australian workplace (Russell, Gerthing and Convery, 1997). Prior to the review, midwifery practice and education were traditionally identified as specialities within the discipline of nursing packaged in the cohort of 'Maternal and Child Health Nursing'.

Midwifery education programs in Australia were found to vary from State to State. Curricula were inconsistent and lacked formal policy direction and national standards. The review recommended the adoption of national midwifery practice standards to assist with the streamlining of midwifery education across Australia. The international midwifery profession had earlier made similar recommendations (Glover, 1999a; Leap et al., 2002). The review also noted that midwifery practice was grouped with all specialist nurse education and recommended changes to differentiate between the disciplines of midwifery and nursing in 1997 (Russell et al., 1997). However minimal progress was made on these recommendations and a subsequent review on nursing and nursing education in 2002, did facilitate a significant change in midwifery education.

The National Review of Nursing and Nursing Education in 2002 did examine specific aspects of nursing and midwifery education by identifying the type of knowledge and skills required to meet the changing needs of the future nursing and midwifery workforce (Heath, 2002). The Heath Review (four years on from the Russell Review) had also recommended midwifery practice be acknowledged as a discipline separate from nursing. As a result a number of undergraduate midwifery programs were offered in Australia. The Bachelor of Midwifery (BMid) became available in four Australian universities from the recommendations of the 2002 review, and in addition to a combined Bachelor of Nursing/Bachelor of Midwifery which had been available since 2001 (Australian Health Workforce Advisory Committee, 2002; Glover, 1999a; Leap and Barclay, 2002; Leap et al., 2002; School of Nursing and Midwifery, Flinders University 2007). Tertiary based post graduate and undergraduate programs in midwifery are currently offered in all Australian states and territories.

The move to the tertiary sector brought with it many changes to programs which had previously been steeped in the traditional apprenticeship model of learning on the job.

These changes included a new theoretical foundation for midwifery knowledge (Greener 1988; Leap et al., 2002). The tertiary curriculum contained a professional body of knowledge based on theory and research and without it the discipline of midwifery would continue to yield no more than random facts of past practices (Houston and Weatherston, 1986; Kelly, 1997; Mander, 1989; Rhodes, 1988).

Current midwifery practice is committed to a 'woman-centred care model' (Price and Price, 1993). The woman-centred care model of practice demands that primary care is centred on the woman and her needs. The change to the tertiary sector and a new curriculum enabled the inclusion of a woman-centred care philosophy.

Midwifery Program

Tertiary midwifery education programs aim to produce graduates who are able to demonstrate their comprehensive discipline knowledge and be clinically competent to begin practice as a professional midwife (Hunter, 2007; Kelly, 1997; Price, 1995; Price and Price, 1993). The integration of theory and practical skills forms the basis for the development of higher-order thinking abilities. The selection for enrolment into a post graduate program requires the student to have acquired 12 months postgraduate experience as a Registered Nurse (RN); along with the ability to meet the entry requirements for admission to a university program and concurrent employment with an accredited hospital maternity unit or community setting throughout the program. Another option also available is the opportunity of direct entry into an undergraduate Bachelor of Midwifery program with dedicated clinical practice experiences.

The midwifery curriculum covers theory and clinical practice requirements. In a typical program, students receive tuition in the care of the childbearing woman and her baby, which involves the theoretical physiological process of normal childbirth and the variations from the normal. The clinical practice development consists of the laboratory and the hospital practice components.

Students' skill development consists of demonstration and practice in the laboratory on the university campus prior to their hospital practice. This supervised practice is at all times under the guidance of a clinical teacher and or experienced midwife mentor (see appendix 1 – statutory clinical requirements). Opportunities in various hospital and community settings are available for students to complete the mandated set of clinical skills. Care of woman in childbirth is an essential midwifery clinical skill and students are required to

master twenty normal births. To attain the necessary knowledge, skill and attitude and complete the skill sets student midwives have time allocated in a delivery suite.

A variety of assessment methods are used in the program. The compulsory items involve progressive written assessments; clinical skills development and experience reflection (see appendix 2 – course outline and appendix 3 – tutorials and midwifery practice topics).

Successful completion of a program entitles the student to register as a midwife with an authorisation to practice midwifery. Program requirements may vary within each Australian state or territory depending on the respective nursing and midwifery regulatory authority; the description above would be a typical example of a tertiary program (ANMC, 2006).

Currently in Australia the tertiary curriculum and the attributes of a midwife are based on the *scope of midwifery practice*, the *decision making guidelines* and the *national midwifery competencies standards* documents which describe all aspects of midwifery practice (Australian Nursing and Midwifery Council (ANMC), 2006) (see appendix 4 – ANMC Competency Standards for the Midwife). These are described in more detail below.

Scope of Midwifery Practice

The Australian States and territories have adopted the International Confederation of Midwives (ANMC, 2006; ICM, 2005) definition of the scope of practice which describes a midwife's entry to practice:

...having been regularly admitted to a midwifery educational program, duly recognised in the country in which it is located, has successfully completed prescribed course of studies in midwifery and has acquired the requisite qualifications to be registered and/or legally licensed to practise midwifery.

The midwife is recognised as a responsible and accountable professional who works in partnership with women to give the necessary support, care and advice during pregnancy, labour and the postpartum period, to conduct births on the midwife's own responsibility and to provide care for the newborn and the infant. This care includes preventative measures, the promotion of normal birth, the detection of complications in mother and child, the accessing of medical care or other appropriate assistance and the carrying out of emergency measures.

The midwife has an important task in health counselling and education, not only for the woman, but also within the family and the community. This work should involve antenatal education and preparation for parenthood and may extend to women's health, sexual or reproductive health and child care.

A midwife may practise in any setting including the home, community, hospitals, clinics or health units.

(The National Competency Standards for the Midwife, ANMC, 2006 p.1).

The midwifery practice statement covers all aspects of a midwife's role. For example, the practice functions and responsibilities, activities and decision making capacity are characterised in this Scope of Practice statement. While some midwifery functions are shared with other professionals (the medical speciality of obstetrics), midwifery practice is influenced by the specific practice settings, legislation, policy, education, standards and the health needs of the population (ANMC, 2006). The emphasis placed on clinical decision making skill is highlighted in the Scope of Practice statement, and the national guidelines or statement of principles is described below (ANMC, 2007).

Decision Making Guidelines

Constructing a hypothesis to analyse and reason clinical decisions is acknowledged as a critical skill for nurses and midwives. This formal '...decision-making tool is part of the nursing and midwifery regulatory authority's professional practice framework ensuring that nursing and midwifery care are provided in the public interest' (ANMC, 2007, p. 6; Orme and Maggs, 1993).

The Statements of Principle provide a guide for midwives within a framework of risk management, to ensure that woman's safety and care are not compromised and / or whether to delegate activities to another health professional (ANMC, 2007 p. 10). The Statements of Principle are:

1. The primary motivation for any decision about a care activity is to meet woman's or baby's health needs or to enhance health outcomes.
2. Midwives are accountable for making professional judgements about when an activity is beyond their own capacity or scope of practice and for initiating consultation with, or referral to, other members of the health care team.
3. Midwives are accountable for making decisions about who is the most appropriate person to perform an activity that is in the midwifery plan of care and would currently normally be performed by a midwife.
4. Midwifery practice decisions are best made in a collaborative context of planning, risk management and evaluation.

(ANMC, 2007 p.11).

The Decision Making Guidelines and the Scope of Midwifery Practice statement capture more information on the attributes of the midwife. Midwives' education aims to equip them with skills in critical thinking and research and to practice safely and is demonstrated in their ability to make assessments and carry out effective care interventions (ANMC, 2007).

National Competency Standards for the Midwife

The final formal national document, supporting and capturing the midwives' professional knowledge and practice, is the National Competency Standards for the Midwife (ANMC, 2006). The National Competency Standards for the Midwife which incorporate the International Confederation of Midwives scope of midwifery practice and the decision making principles '*...provide the details of the knowledge, skills and attitudes expected of a midwife to work within the midwifery scope of practice*' (p, 3). The foundation of midwifery competency standards originated within the national competency movement to standardise health professionals' practice and the emerging discipline of midwifery (Benner, 1984; Glover, 1999b; Gonczi, 1999; Gonczi, Hagar and Oliver, 1990; Williams, 1989).

The development of practice standards for all professions by the Australian National Office of Skills Recognition (NOOSR) was the response to a Federal Government requirement for migrant skill recognition, and a national approach to the standardisation of skills and technology levels. In 1991 the National Training Board (NTB) developed a framework for '*...vocational training, curriculum development, industry training, and recognition, and the delivery of accredited training*' (Glover, 1993a p.16). The Australian Vice Chancellors Committee (AVCC) supported this position for competency based education and training, with Australian universities working in partnership with the professions '*...through a consultative process which ensured that curricula in the tertiary sector met both academic and professional requirements*' (Glover, 1993a p.17). The competency standards are described below:

...in the knowledge section of the curriculum...and...regarded as being foundational to practice. This is the context-free knowledge that the curriculum designers decide is needed for future practice. There is also a skills section of the curriculum that is designed from a list of all those isolated skills – psychomotor and attitudinal - that the effective practitioner is deemed to need.

(Hager and Butler, 1994).

From this pragmatic assessment of practice, the measurement of knowledge levels began to broaden to include the integration of knowledge with skills and attitudes (Cutts, 1995a; Glover, 1999b; Gonczi et al., 1990; Masters and McCurry, 1990). This led to the development of competency based standards. As a result, the integration of professionals' knowledge, skills and attitude served as a general benchmark for all practice assessments and assisted in the advancement of discipline based practice (Benner, 1984; Hager and Butler, 1994).

The application of professional competency based standards is not limited to the measurement of knowledge or a list of psychomotor skills to be checked off. Units of competence are made up of a combination of attributes (discipline specific knowledge, various levels of psychomotor skills, attitudes and values) with the assumption that over time competence develops with experience in discipline specific practice (Benner, 1984; Gonczi, 1994; Gonczi et al., 1990).

In the discipline of nursing, competency standards were developed in the 1980s. Prior to the 1980s nurses' competence had been assessed by an expert. With the need to understand the relationship between knowledge and skilled practice at that time Benner (1984) developed a Model of Professional Nurse Development. The model, based on clinical observation and analysis, used the Dreyfus model of knowledge acquisition and skill development, which identified five levels of proficiency (1980, cited in Benner, 1984). The levels of proficiency include the *novice*, *advanced beginner*, *competent*, *proficient* and *expert* and their defining characteristics appear in table 1.1 below. These levels of proficiency provided a method to measure the development of a nurse's practice and recognised how nurses make the transition from novice to expert to become specialists in their field (Adams, Pelletier, Duffield, Nagy, Crisp, Mitten-Lewis, Murphy, 1997; Benner, 1984; Glover, 1999b).

Table 1.1: Model of Professional Nurse Development

Level	Characteristics
Novice	<p>No experience in the situation Dependent upon rules to guide their actions Unable to transfer knowledge Detached observer</p> <p>Requires supervision and assistance with practice</p>
Advanced Beginner	<p>Task-oriented, can identify aspects, organises and prioritises tasks Still uses procedural lists Some limited exposure to real situations Remains focussed on rules Marginal satisfactory performance Recognises clinical signs and symptoms however often unable to link and reason the outcome</p> <p>Less likely to grasp variation and patterns within particular situations</p>
Competent	<p>Clinical postgraduate experience of 2-3 years Actions based upon conscious, abstract, analytical reflection of a problem Able to prioritise attributes and aspects, often lacks speed and flexibility Mastery of skills in the clinical setting Functions and manages in the clinical nursing context Increased responsibility, can explain and interpret situations</p> <p>Can work independently, planning based on goals</p>
Proficient	<p>A quantum leap from competency, perceives situations as a whole performance guided by principles; no longer rules Can recognise when normal is absent Considers fewer options when trying to solve problems</p> <p>Functions independently, sees changing relevance, can anticipate potential problems, has experiential knowledge</p>
Expert	<p>Intuitive behaviour/practice Minimum of 5 years clinical postgraduate experience Able to quickly assess critical areas in a problem situation Considers multiple solutions, intuitively knows which solution will work Holds deep grasp of clinical situations based on years of experience In new situations, uses highly skilled analytical abilities</p> <p>Manages rapidly changing situations, able to attend to many other aspects of care, simultaneously manages multiple complex therapies</p>

(Benner, 1984; Benner, Tanner and Chesla, 1992)

In the 1980s the first formal regulating framework to guide midwifery professional practice was established in Australia (Barclay, 1984; NSW Health, 1995). The framework provided a consistent standard for midwifery education programs and regulated the authorisation to practice midwifery in NSW. It was the only state in Australia to adopt this guide. These standards were also used as a tool to assess continuing education and post graduate practice (NRB, NSW circular No. MD 1987 / 1; NSW Health, 1995).

The midwifery professional body, Australian College of Midwives Incorporated (ACMI), in consultation with the regulatory authorities of all Australian States and territories, produced the first national competency standards for midwives in 1998 (Glover, 1999b). The contemporary midwifery practice and performance criteria statements described behaviours or practices for which midwives are accountable, and served as a benchmark for practice (ACMI, 1998).

The 1998 competency standards were organised into four practice domains and 14 competency units which illustrated the performance criteria within each domain. The domains were:

1. *Professional responsibility and accountability domain (in 4 competency standards);*
 2. *Midwifery practice domain (in 8 competency standards);*
 3. *Health education and promotion domain (in 1 competency standard) and;*
 4. *Legislation, policies and procedures domain (in 1 competency standard).*
- (ACMI, 1998).

In 2005, the 1998 ACMI standards were reviewed and revised to reflect the changing focus of an emerging midwifery profession and woman centred model of care, within a social health and wellness framework (AMCI, 2005; Cutts, David, McIntyre, Seibold, Hopkins and Miller, 2003). The revision was conducted by the newly formed Australian Nursing and Midwifery Council (ANMC) which was established to standardise the practice of nurses and midwives, including the enrolled nurses and nurse practitioners (Homer, Passant, Kildea, Pincombe, Thorogood, Leap, and Brodie, 2007; Leap and Barclay, 2002; NSW NMB, 2007).

The current national competency standards for the midwife are represented in four *clusters of competencies*, in midwifery practice domains. The four practice domains described below are represented by 14 midwifery competency standards:

1. *Legal and professional practice*

This domain contains the two competencies that relate to legal and professional responsibilities including accountability, functioning in accordance with legislation affecting midwifery and demonstration of leadership.

- | | |
|---------------|--|
| Competency 1: | functions in accordance with legislation and common law affecting midwifery practice |
| Competency 2: | accepts accountability and responsibility for own actions within midwifery practice |

2. *Midwifery knowledge and practice*

This domain contains the four competencies that relate to the performance of midwifery practice including assessment, planning, implementation and evaluation. Partnership with the woman is included in this domain.

Competency 3:	communicates information to facilitate decision-making by the woman
Competency 4:	promotes safe and effective midwifery care
Competency 5:	assesses, plans, provides and evaluates safe and effective midwifery care
Competency 6:	assesses, plans, provides and evaluates safe and effective midwifery care for the woman and/or baby with complex needs.

3. *Midwifery as primary health care*

This domain contains the four competencies that relate to midwifery as a public health strategy. Included are the notions of self-determination and the protection of individual and group rights.

Competency 7:	advocates protecting the rights of women, families and communities in relation to maternity care
Competency 8:	develops effective strategies to implement and support collaborative midwifery practice
Competency 9:	actively supports midwifery as a public health strategy
Competency 10:	ensures midwifery practice is culturally safe.

4. *Reflective and ethical practice.*

This domain contains the four competencies relating to self-appraisal, professional development and the value of research.

Competency 11:	bases midwifery practice on ethical decision making
Competency 12:	identifies personal beliefs and develops these in ways that enhance midwifery practice
Competency 13:	acts to enhance the professional development of self and others
Competency 14:	uses research to inform midwifery practice.

(ANMC, 2006 p. 3 – 4 - 7).

Each competency standard consists of units and sub-functions of elements with generic performance cues that characterise the central aspect of all midwifery practice (see appendix 4). The major areas within each unit are stand-alone functions that can be achieved individually. For example, competency unit 6 describes the midwife's practice, '*...assesses plans, provides and evaluates safe and effective midwifery care for the woman and / or baby with complex needs*' (ANMC, 2006 p.5 - 6). This unit contains two very important competency elements to demonstrate experienced judgment, and a measure of expert professional practice knowledge (Siddiqui, 1994). The elements of 6.1 and 2 are examples of the behaviour and relevant cues to demonstrate then measure practice:

Element 6.1 'utilises a range of midwifery knowledge and skills to provide midwifery care for woman and her baby with complex needs as part of a collaborative team'; and the relevant cue, 'demonstrates a sound knowledge base of relevant disease processes and health complexities'.

Element 6.2 recognises and responds effectively in emergencies or urgent situations; and the relevant cue, 'recognises and responds to any urgent or emergency situations with timely and appropriate intervention, consultation and /or referral.'

(ANMC, 2006 p. 5 - 6).

Cue statements contain generic examples that are illustrative of midwifery practices, and are designed to measure competent performance and assist with the assessor's professional judgement of students' practice knowledge and performance (Cutts, 1995b). The practice competency standards measure the professional practice performances expected of a midwife and are descriptive in nature.

A sound knowledge base is required of midwives to make quality decisions which involve an association between the standards and the development of a midwifery knowledge base. However the role of knowledge and practice engagement is not clearly articulated in the standards. While the competency standards 3, 4, 5 and 6 explain midwifery performance, the detail of how midwives develop practice knowledge, its structure and its use in practice, are not explicit.

Midwifery Practice Research and the Development of Expertise

Midwifery practice is described as responsive rather than directive by its nature. Midwives work in partnership with women and other team members (Fleming, 1998; Greener, 1988; James, Simpson and Knox, 2003; Kelly, 1997; Price and Price, 1993). Midwifery practice involves caring for the woman's physical needs as well as her emotional responses. Of equal importance in this woman-centred care model is being with the woman and knowing the person by forming an interpersonal relationship rather than having a detached understanding of her situation (Cioffi, 2002; Benner 1984; Danerek and Dykes, 2001; Hedberg and Larsson, 2003; James et al., 2003; Jenny and Logan, 1992; Kelly, 1997; Kirkham, 2000; Radwin, 1995; Sutton and Smith, 1995; Tanner et al., 1993). The woman-centred care model and midwifery competency standards (outlined above) contain all aspects of midwifery practice; identify the professional midwife (ANMC, 2006).

In the literature expert midwives are described by their years of experience working with women, and of having a discipline and clinical practice knowledge base (Danerek and Dykes, 2001; Freeman, 2003; James et al., 2003; Orme and Maggs, 1993; Sutton and Smith, 1995). Experts are defined by their discipline specific knowledge and problem solving abilities. They use information retrieved from a highly developed network of discipline knowledge and make greater use of memory representation to reason their decisions (Ericsson and Simon, 1993). Elstein and colleagues summarised experts' reasoning in non-problematic situations as

looking ‘...like pattern recognition of direct automatic retrieval from a well-structured network of stored knowledge’ (1990, p.10). Experts are skilled and efficient in their practice which allows them to focus on all other aspects of care. These important features are highlighted by a number of characteristics:

1. a greater ability to organise information into semantically meaningful, interrelated chunks;
2. no processing of irrelevant information;
3. in routine situations they tend to use highly specific knowledge based problem solving strategies.

(Ericsson and Smith, 1991).

The problem solving abilities of seven experienced midwives were examined in a study by Danerek and Dykes (2001). The reasoning skills of the experienced midwives were found to be based on the integration of theoretical knowledge and clinical practice experience. This knowledge gave midwives the ability to quickly assess and identify the whole problem, to make rapid decisions and reach a positive outcome.

Danerek and Dykes described the midwives’ reasoning processes in critical situations and in the absence of a doctor, as multifaceted. These were structured in 13 sub-facets. The structures of sub-facets contain the following components:

1. listening to woman and trusting her description of the situation
2. accessing and allowing her knowledge to guide decisions
3. making a fast decision and taking immediate action
4. using knowledge and experience gained during different situations
5. acknowledging intuition provides position of strength where the midwife acts instinctively helped by experience
6. identifying a problem and finding a solution with their acquired professional knowledge
7. co-operation
8. engagement of others and resources
9. purposefulness by looking forward on the developing situation
10. concentration on the task
11. euphoria managing the situation
12. careful consideration
13. control of the situation with confidence in her professional knowledge.

(Danerek and Dykes, 2001 p.181).

The authors found that midwives made their decisions in a ‘flow’ by using the components of ‘...engagement, purposefulness, concentration in a state of euphoria within the birthing context’ (p.182). Danerek and Dykes (2001) clarify the ‘flow’ as a sense of timelessness and complete concentration on the task that excluded all other irrelevant mental activity.

Complete concentration on the task makes greater use of memory representation, from a

highly developed structured knowledge, which is a feature of expertise (Ericsson and Simon, 1993).

The importance of midwives' structured prior knowledge and their problem solving ability were highlighted in the study. However Danerek and Dykes did not address the question of how this knowledge is acquired, how it develops and how it is structured.

A larger study of 54 expert midwives (labour ward nurses with five years' experience) described that their problem solving ability was guided by the four elements of knowledge listed below:

1. Knowing the labour process and the intuitive nature of nursing care based on years of experience
2. Knowing the woman and letting her body guide the labour
3. Being an advocate for the labouring woman
4. Autonomy within the nurse-managed model of woman's labour

(James et al., 2003 p. 818).

The authors suggest that these four elements are interrelated and that the nurses' prior knowledge and experiences are the basis for their expert practice. Expert practice (in the labour and birth) contributed to the midwives' confidence and their autonomy to manage all clinical situations, which included knowing when to refer their decisions to another health professional. They were found to be an advocate for the labouring woman and described themselves as supportive, caring, and effective experts in this woman-centred model of care.

The experienced labour ward nurses were able to discriminate between reliable and unrelated data based on their past experiences and to integrate it with practice. For example, when positioning the woman in labour a nurse explained '*...I know positioning is a big thing; probably the biggest...(and)...upright positions are best. Sitting on the toilet does wonders for most women...(as)... it helps open the pelvis and rotate the baby*' (p. 818). In this instance the expert labour nurse illustrated the relationship between the woman's position and recognised data cues from her prior knowledge and experience to reason her decision. James and colleagues called the expert midwives' knowledge their 'bag of tricks' (2003).

While James and colleagues (2003) had indicated that the relationship between knowledge, clinical experiences and practice skills was the midwives' 'bag of tricks', the process by which the expert nurses structured this practice knowledge was not addressed in the study.

Orme and Maggs (1993) found similar characteristics among expert decision makers in their study. They suggested that midwives have a sound discipline specific knowledge base and

are able to access a wide array of information and resources. Decision making was influenced by the rapid assessment and judgments often required during birth (Marchant, 2005; Orme and Maggs, 1993). Expert decision makers often relied on a 'gut feeling' of the situation and are concerned for patient safety, by understanding the risks, and by recognising their own and others' limitations. The midwives were found to use reflection and evaluation processes in their practice, however the researchers did not elaborate on the process of how they developed discipline specific knowledge.

A further study of midwives' decision making processes found them to be similar to those of a medical model of care (Freeman, Adair, Timperley and West, 2006) and not of the woman-centred model. Although the majority of the midwives worked in the continuity of care model, one midwife with one woman for the birth, the study identified the practice procedures they used were often dated and traditional with a reliance on technology in their decision making. However, midwives were found to adopt a humanistic rather than a technical approach when providing care. Freeman and colleagues indicated that this humanistic approach pointed towards woman-centred care and was used in combination with technology and traditional practices.

The studies of midwifery practice suggest that the clinical problem solving and decision making skill of the experienced midwives develop from relationships with birthing women, and a sound discipline and clinical knowledge base that has developed through past experiences (Danerek and Dykes, 2001; Freeman et al., 2006; James et al., 2003; Orme and Maggs, 1993; Siddiqui, 2005; Sutton and Smith, 1995). These midwifery studies described the intuitive woman-centred care model of practice. The assumption is that successful clinical reasoning and decision making skill are dependent on formally acquired specific discipline knowledge which has been developed from clinical practice experiences into professional discipline specific knowledge, is the essential component of safe and effective health outcomes (Benner, 1984, 2001; Danerek and Dykes, 2001; Ericsson and Smith, 1991; Patel, Groen and Arocha, 1990).

While midwifery studies identified that structured knowledge was important, they do not shed light on how individuals develop their structured knowledge base. The rigor and conceptual clarity of midwives' knowledge growth and the role of knowledge in reasoning clinical decisions does not appear to be clearly defined in the available midwifery literature. The development of a midwife's knowledge base, its structure and accessibility when called upon to reason clinical problems and make decisions, is the major theme of this research. The

studies of decision making in the midwifery literature appear to be limited, and those that are reported remain largely informed by the disciplines of medicine and nursing (Mok and Stevens, 2005).

Therefore to further understand the role of knowledge in clinical decision making the research literature of other health professions and the cognitive sciences are reviewed in the next part of this chapter. The clinical decision making models – hypothetico-deductive and knowledge-driven models are discussed next.

Clinical Decision Making

The problem reasoning and clinical decision making of the health care professionals are an important function of their role. The demanding world of health care clinical decision making is a complex process which occurs in rapidly changing situations in different clinical settings (Alexander, 1997; Benner, 1984; Benner et al., 1992; Giroto, 2000; Grobe, Drew and Fonteyn, 1991; Lauri and Salanter, 1998).

The first generation of health care professional studies, examining the nature of expertise in the problem solving and reasoning skills in the 1940-50s, were associated with the reasoning processes of medical clinicians (Daley, 1999; Higgs and Jones, 2000; Patel and Arocha, 2000). Initially, the studies of reasoning focused on predicting clinicians' behaviour. However two decades later studies altered their focus to the role of knowledge, how it is stored in memory and used in the reasoning process. Influential in this change were studies that characterised reasoning processes of novice and expert clinicians (Elstein, Shulman, and Sprafka, 1978; Higgs and Jones, 2000).

Studies examining the differences between novice and experts had focused on expertise in reasoning clinical problems (Bordage, Grant, and Marsden, 1990; Ellis, 1997; Tanner, Padrick, Westfall and Putzier, 1987); the use and structure of knowledge in reasoning clinical problems (Bordage, and Lemieux, 1991; Boshuizen and Schmidt, 1992; Boshuizen, Schmidt, Custers, and van den Wiel, 1995; Grant and Marsden, 1987; Schmidt and Boshuizen, 1993); and the processing of clinical data to reason a diagnosis (Patel et al., 1990).

The seminal work of Elstein and colleagues (1978) identified a set of cognitive processes explaining the complexities of clinical problem solving which became known as the hypothetico-deductive reasoning model. Studies examining the hypothetico-deductive reasoning model in clinical practice are examined next.

The Hypothetico-Deductive Model

The hypothetico-deductive Model describes reasoning of clinical decisions by a process of hypothesis testing. The hypothetico-deductive theoretical framework is characterised by a defined, sustained set of problem solving processes. The process involves:

- 1) data identification or sometimes described as the cue acquisition stage (of the patients clinical signs and symptoms)
- 2) hypothesis generation
- 3) information gathering
- 4) problem reformulation
- 5) the hypothesis evaluation

(Elstein et al., 1978; Elstien, 1992).

There are two types of reasoning methods used in hypotheses testing, backward reasoning and/or the pattern recognition of forward reasoning. The type of reasoning used is dependent upon the nature of the task, the level of knowledge and practice experience of clinicians (Arocha, Patel and Patel, 1993; de Jong and Ferguson-Hessler, 1986; Elstein et al. 1978; Eva, Brooks and Norman, 2002; Gordon, 1994; Hassebrock and Prietula 1992; Joseph and Patel 1990; Putzier, Padrick, Westfall, and Tanner, 1985; Narayan and Corcoran-Perry, 1997; Newell and Simon, 1972; Tanner et al., 1987).

The backward reasoning strategy is a deductive process. The strategy is described as a shift from the tentative diagnosis identified from data cues, to a search through multiple hypotheses to support or substantiate an outcome. As a result backward reasoning strategy is often slow, effortful and characteristic of the novice (Ericsson and Charness, 1994; Eva et al., 2002). Forward reasoning is an inductive process, reasoning from data cues to a diagnosis with a single hypothesis in mind for an outcome. It begins early in the task (Patel and Groen, 1986). Data cues are interpreted from patterns of prior knowledge to prove or disprove the hypotheses. This provides a faster more efficient reasoning process, going from data to diagnosis, and is characteristic of the expert (Eva et al., 2002; Patel and Groen, 1986).

Experts process data effectively and make accurate decisions within their discipline. However, studies have shown when experts are asked to make a decision outside their discipline, or encounter an unfamiliar and difficult clinical situation they reverted to a backward reasoning process (Eva et al., 2002; Newble, Norman and van der Vleuten, 2000; Patel et al., 1990; Patel and Kaufman, 2000). In this situation the experts relied on the basic

principles of biomedical and theoretical knowledge to reason and arrive at the best solution for the problem.

Studies have suggested both novice and expert have a higher degree of diagnostic accuracy when using the backward reasoning approach (Elstein and Schwartz, 2000; Eva et al., 2002). However the structure of novice and expert knowledge plays an important role in understanding and representing the clinical problem rather than in describing their reasoning abilities. This implies that reasoning goes beyond data acquisition, hypothesis generation, problem formulation and hypothesis evaluation. It relies on the structure of an individual's prior discipline specific knowledge, which has an influential role in the reasoning process (Newble et al., 2000).

A structured discipline knowledge base was recognised as being important in the decision making process but more importantly it is the quality of the hypothesis that results in successful reasoning and accurate diagnostic outcomes. As the hypothetico-deductive model did not account for the differences between the structure of novices and experts' discipline specific knowledge, the knowledge driven reasoning models were examined.

Knowledge-Driven Model

The knowledge driven model is defined by the well-structured, discipline specific prior knowledge in memory which is accessed to reason and to make clinical decisions. The model differentiates between the significant role of a prior knowledge base, the structure of knowledge and the use of knowledge in clinical reasoning problems. Experienced clinicians are able to link clinical data cues with their prior knowledge, and to develop hypotheses to make quality decisions that lead to accurate diagnosis. The clinical reasoning skill of an individual and their discipline knowledge are interdependent (Boshuizen and Schmidt, 1992; Schmidt and Boshuizen, 1993).

On the other hand medical students' use of knowledge when reasoning clinical decisions is related to their level of expertise and the major contributing factor to diagnostic accuracy is the quality of their structured prior knowledge (Balla, Biggs, Gibson, and Chang, 1990; Boshuizen and Schmidt, 1992). The students' level of understanding varies: novices have less prior knowledge to reason with, leading to incorrect diagnosis. However, as the increase of knowledge connections of like information begin to form, knowledge transforms during the course of learning through continual exposure to patient problems in the clinical setting (Boshuizen and Schmidt, 1992; Grant and Marsden, 1988; Patel and Groen, 1986; Schmidt

and Boshuizen, 1993). It is the structure of an individual's knowledge base defines their discipline specific knowledge and level of expertise.

Knowledge Structure

Knowledge develops in stages (Boshuizen and Schmidt, 1992, Cantwell, 2004). The development of a discipline specific knowledge structure begins with learning external information, such as the information from books and formal lectures. In the initial stage knowledge consists of an accumulation of isolated pieces of information that have little meaning because they are not associated with previous information or to each other (de Jong and Ferguson-Hessler, 1996; Glaser, 1991; Grant and Marsden, 1988; Hunter, 2007; Siddiqui, 2005).

The developmental changes in knowledge begin with each piece of like information connecting to form a network; and through a process of restructuring and reframing the networks of information clusters together to form categories of discipline knowledge (Boshuizen and Schmidt, 1992; Boshuizen et al., 1995). With increasing knowledge and experience the categories become synthesised with prior knowledge into meaningful units or patterns of discipline knowledge as a whole, rather than discrete pieces of disease knowledge (Cantwell, 2004; Larkin, McDermott, Simon, and Simon, 1980). Knowledge not stored in this manner may be lost or not easily retrieved when required (Alexander, 1992; Alexander, 1996; Bordage and Lemieux, 1991; de Jong and Ferguson-Hessler, 1996).

These qualitative changes in thinking are defined by a theory of cognition described in a sequence of learning stages. During the stages two distinct qualitative 'cognitive shift' changes in thinking occur. The quality of thinking in the learning stages is equivalent to the five levels of understanding in the Structure of the Observed Learning Outcome (SOLO) taxonomy (see Appendix 5 for the full details) (Biggs and Collis, 1989; Cantwell, 2004).

The midwifery practice literature established that individuals' structured discipline specific knowledge is linked with expert reasoning and clinical decision making accuracy. The developmental structure of individuals' knowledge base is a combination of different types of knowledge. Midwives' knowledge is illustrated by the general midwifery competency standards of knowledge skill and attitude in the National Competencies Standards for a Midwife.

Knowledge Types

The ANMC National Midwifery Competencies Standards feature the knowledge, skills and attitudes of a midwife as the essential components of midwifery practice knowledge outlined above (ANMC, 2006). The theoretical description of the what, how and why of an individual's discipline knowledge base was established in three types are similar to the knowledge, skills and attitudes of a midwife. The three types are:

- 1) *declarative knowledge*
- 2) *procedural knowledge*
- 3) *conditional knowledge*

(Alexander and Judy, 1988; Biggs and Telfer, 1987; Chartier, 2001; Cust, 1995; de Jong and Ferguson-Hessler, 1996; Glaser, 1984; Higgs and Titchen, 2000; Schraw and Moshman, 1995).

Declarative knowledge represents the factual and theoretical or basic scientific pathophysiological and psychosocial disease process. This type of knowledge provides the foundation and its subsequent structure is the body of discipline knowledge (Alexander and Judy, 1988; Chi, Feltovich and Glaser, 1981). Knowledge of empirical facts and theories during the course of learning external information provides the basis of a discipline specific declarative knowledge available to be applied in practice (Cameron-Traub, 1995; Cust, 1995; Hunter, 2007; Siddiqui, 2005).

Procedural knowledge represents individuals' skill knowledge that, combined with their declarative knowledge, demonstrates an individual's practical expertise and professional craft knowledge (Alexander and Judy, 1988; Higgs, 2004; Siddiqui, 2005). Procedural knowledge involves the practical principles and guidelines of individuals' reasoning strategies of pattern recognition or the skilled actions required for the task with the former often triggering the other later (Cervero, 1992; Cust, 1995; Schraw, 1998; Tanner, 1998). Procedural knowledge is expressed as guiding day to day practice and knowing how to do what is needed when caring for patients (Benner, 1984; Benner, Hooper-Kyriakidis, and Stannard, 1999; de Jong and Ferguson-Hessler, 1996; Siddiqui, 2005); and underpins skilled nursing action as an '*...experienced nurse probes with a catheter tip as if it were an extension of her fingers, not an unwieldy foreign object*' (Benner and Tanner, 1987 p. 26).

Conditional knowledge represents individuals' personal or professional practice knowledge. The basis of conditional knowledge is the 'when' and 'why' of a task that has been developed through the continual growth of individuals' declarative and procedural knowledge (Alexander

and Judy, 1988; Cust, 1995; de Jong and Ferguson-Hessler, 1996, Schraw and Moshman, 1995). This type of knowledge, gained from experiences, shapes an individual's perspective within the practice discipline and reflects the many characteristics of an organised belief system that is able to influence decision making (Ennis, Cothran and Loftus, 1997; Higgs, 2004).

The use of conditional knowledge to make judgments and reason decisions is characteristic of clinical expertise. Knowing when and how to engage this knowledge is important in clinicians' decision making. All fields of study have declarative, procedural and conditional knowledge dimensions (Alexander, 1992; de Jong and Ferguson-Hessler, 1996). These knowledge types are used in establishing the theoretical and methodological framework for the study's design.

The Use of Knowledge in the Reasoning Process

The way in which experts structure their discipline specific knowledge has been characterised in the literature using various terms. For example, the schema theory, illness scripts and pattern recognition are the terms used to describe an individual's prior knowledge. This prior knowledge is organised into networks or patterns of knowledge as well as the skills and used to reason clinical decisions. Schema theory describes the structure of prior knowledge as schematic networks. These networks have been constructed by a series of abstractions developed by direct experience with similar patient problems (Balla et al., 1990; Corcoran-Perry and Narayan 2000; Patel and Groen, 1986).

Illness scripts consist of networks of prior knowledge structures of problem representations. These networks contain enabling conditions, the condition's pathophysiology, and the consequences of the condition. This type of structure is readily accessible for reasoning and decision making (Boshuizen and Schmidt, 2000). Illness scripts are used to match data cues and reason an outcome and are de-activated if elements of data do not correspond (Boshuizen and Schmidt, 2000; Feltovich and Barrows, 1984). Schmidt, Norman and Boshuizen (1990) described schematic networks of knowledge and illness scripts as sophisticated forms of pattern recognition.

Pattern recognition of clinical problems is described by an inductive forward reasoning strategy known as the standard problem solution rule or management strategy or protocol (Greener, 1988). Patterns of previous problem situations are held in networks of highly structured knowledge together with reasoning strategies and are used to prove or disprove a

hypothesis. This is often described as an unconscious integration of critical thinking and data processing (Carnevali, 1984; Narayan and Corcoran-Perry, 1997).

There are similarities in these structures of prior knowledge. They are characteristic of structured knowledge bases containing problem representations used to make judgments and reason clinical decisions. A structured knowledge base is necessary to inform reasoning decisions in complex situations and without it decisions would be ineffectual, erroneous and sometimes inaccurate (Corcoran, 1986a; Corcoran, 1986b).

Semantic networks, schema theory, causal scenarios, illness scripts or pattern recognition of structured prior knowledge are all terms that were found to be used by experienced clinicians to reason clinical problems (Balla et al., 1990; Boshuizen and Schmidt, 2000; Corcoran-Perry and Narayan 2000; Patel and Groen, 1986). The reasoning strategy, using prior knowledge in this way, is the recognition of familiar patterns in the problem from data cues and then matching to an appropriate schema with similar patterns from the pre-stored prior knowledge structure which has been developed from past experience with similar patients.

The accessible highly structured network of discipline specific knowledge is central to successful reasoning and decision making, and the best predictor of diagnostic accuracy (Biggs and Telfer, 1987; Chartier, 2001; Grant, and Marsden, 1987; Grant, and Marsden, 1988; Mandin, Jones, Woloschuk, and Harasym, 1997); and of clinical diagnostic ability (Bordage et al., 1990; Gale, 1982; Gale and Marsden, 1982; Grant and Marsden, 1987; Grant and Marsden 1988).

How much knowledge or what type of knowledge individuals have appears not to be as important as its structure (Arocha et al., 1993; Bordage and Lemieux 1991; Boshuizen and Schmidt, 2000; Chi, Feltovich and Glaser, 1981; Higgs and Jones, 2000; Jones, Jensen and Edwards, 2000; Patel and Groen, 1986; Patel and Kaufman, 2000; Schmidt and Boshuizen, 1993). The evolution of a sophisticated knowledge structure has been strongly linked to reasoning complex clinical problems and differentiates the expert from the beginner's practice (Alexander, 1996; Benner, 1984; Boshuizen and Schmidt, 1992; Cholowski, 1998; de Jong and Ferguson-Hessler, 1996; Glaser, 1984; Glaser and Chi, 1988).

Experts have established readily accessible structured discipline knowledge. The novice however, has knowledge structures that are not sufficiently developed to enable them to piece together data cues and make the link to their prior knowledge. Their knowledge

structure has gaps which hinder the construction of an hypothesis resulting in weaker links between items of knowledge that often lead to limited problem representation and inaccurate diagnoses (Azzarello, 2003; Corcoran, 1986a; Corcoran, 1986b; de Jong and Ferguson-Hessler, 1996).

The structure of discipline specific knowledge base develops from declarative knowledge, as a structured collection of facts. The integration of declarative knowledge with procedural knowledge, clinical practice skills and techniques, continually evolves with practice experience. During this qualitative process knowledge becomes structured to form links and relationships between facts, the task itself and patterns of specific clinical practice outcomes. Conditional knowledge employed to make judgments and reason decisions by knowing when and why to apply declarative and procedural knowledge is the nature of an individual's practice discipline.

On this basis it is hypothesised that the account of a discipline specific knowledge would translate to describe a midwife's knowledge base. This study will investigate the development of midwifery knowledge and its role in reasoning and decision making during the development of expertise in practice.

The Aim of the Study

The aim of this study was to examine student midwives' knowledge growth and clinical decision making and compare it to that of experienced midwives performing a normal birth task. There appears to be a paucity of midwifery literature therefore the outcome of the study will provide critical information on the acquisition of knowledge during the development of students' knowledge and the role of knowledge in clinical practice.

In order to examine how midwives' knowledge develops during the transformation from student to midwife the research literature from the hypothetico-deductive model and the knowledge driven model is examined in chapter two. The hypothetico-deductive model represents the deductive reasoning process but does not adequately explain individual differences, in particular, the use of relevant prior knowledge or its structure and accessibility. Therefore for this study the knowledge-driven model is reviewed. With its emphasis on the role and importance of a structured knowledge base, it may account for differences between the reasoning of the student as opposed to that of the experienced midwife.

The study's research questions asked:

- 1) What is the nature of the differences between midwifery students (after their first and twentieth birth) and experienced midwives in their use of declarative, procedural and conditional knowledge when making clinical decisions during a normal birth?
- 2) What is the nature of midwifery students' discipline specific knowledge after their first and twentieth birth when making clinical practice decisions?
- 3) What is the nature of experienced midwives' discipline specific knowledge?

The Structure of the Thesis

The thesis is organised in six chapters.

Chapter One: Introduction to the Study

Chapter one introduced the study context with a brief history of Australian midwifery education from 1862 to the present time including an overview of the National Competency Standards for the Midwife. The midwifery practice and clinical decision making research literature is described and is followed by other health professionals' clinical decision making practice research literature and knowledge development.

The aim of the study is to examine midwives' knowledge growth and the clinical decision making paradigms of students and experienced midwives when performing a normal birth task.

Chapter Two: The Literature Review

Chapter two reviews empirical clinical reasoning studies which are conceptually grounded in the hypothetico-deductive reasoning model, and the knowledge-driven model.

Chapter Three: The Development of a Practice Knowledge Base

Chapter three explores how knowledge is transformed into professional clinical practice by exploring the development of knowledge structure. The developmental changes to thinking and how novices and experts structure their knowledge are investigated. This chapter defines and accounts for the developmental progress of midwifery discipline specific knowledge base within different levels of practice. The process outlines theoretical sequences that systematically hypothesise midwives' discipline specific knowledge structures.

Chapter Four: The Study Methodology

Chapter four outlines the study's design, the subjects and the ethical considerations. This is followed by a description of data collection, which includes the developmental constructs of the structured interview, and its association with the birth task. The procedures used to transform verbal data into protocol segments are explained. The second part of the chapter details the development of the study's coding scheme to quantify students' and midwives'

data using the verbal protocol analysis method. Finally, an account of the analysis techniques selected to answer the research questions are documented.

Chapter Five: The Results

Chapter five is in two sections: the results of the quantitative analysis are reported in section one and the qualitative case study analyses are reported in section two.

Section one detail the findings of the quantitative analysis that examined the prior knowledge used by students (after their first and twentieth birth) and midwives, to answer the research questions.

- 1) What is the nature of the differences between midwifery students (after their first and twentieth birth) and experienced midwives in their use of declarative, procedural and conditional knowledge when making clinical decisions during a normal birth?
- 2) What is the nature of midwifery students' discipline specific knowledge after their first and twentieth birth when making clinical practice decisions?
- 3) What is the nature of experienced midwives' discipline specific knowledge?

The results are presented in three data sets representing the differences between the groups, the differences in relevance and the differences between groups and relevance. This section incorporates a discussion on the quality of the data and interpretation of the findings.

Section two reports the cases of two student midwives (after their first and twentieth birth) and two experienced midwives, illustrating the individual differences in the structures of discipline specific knowledge. The outcome of this analysis captured the differences that characterised their knowledge structures in levels of understanding. The cases represent the data from two typical students (after their first and twentieth birth) and those of two midwives, explaining their knowledge and decision making as recalled while performing a normal birth task.

Chapter Six: Discussion and Conclusions

Chapter six draws together and discusses the study's findings. The findings of the quantitative analysis showed there was a difference between quantity and quality of

students (after their first and twentieth birth) and of midwives in the use of declarative, procedural and conditional knowledge. The case study analysis captured the differences between the structure of discipline specific knowledge students and experienced midwives. As a result these findings and the implications for practice and learning are highlighted. The limitations of the study are discussed, including the relevance for practice and recommendations for future research.

CHAPTER TWO: THE LITERATURE REVIEW

The previous chapter provided the background for this study. The few studies that were located in the existing midwifery literature, and the AMNC National Competency Standards for a Midwife identified that for expert midwifery practice midwives need a sound discipline specific knowledge base in order to reason and make accurate decisions in a woman centred model of care (ANMC, 2006; Danerek and Dykes, 2001; Freeman et al., 2006; James et al., 2003; Sutton and Smith, 1995). The current literature and the midwifery practice standards however, provided little insight into how this sound discipline specific knowledge develops. Therefore in order to gain some insight into this process, a review of the cognitive science and health professionals' literature was consulted. There were two major theoretical frameworks in the decision making literature: the hypothetico-deductive model of diagnostic reasoning and the knowledge-driven reasoning model.

In this chapter the clinical studies on decision making and problem solving using the hypothetico-deductive and knowledge-driven models are examined in detail. The review of the literature is organised into two sections. The review begins with clinical studies using the hypothetico-deductive model framework, followed by studies using the knowledge-driven model framework with specific reference to the character of prior knowledge, its structure and role in reasoning clinical problems.

The Hypothetico-Deductive Reasoning Model

Defining the Hypothetico-Deductive Reasoning Model

In 1978 Elstein and colleagues' seminal study examined the clinical reasoning processes of 24 experienced medical clinicians. The clinicians were an opportunistic sample of 12, recommended by peers as 'good' clinicians. The study also included 12 experts. All clinicians were given three simulated case scenarios to read. Each scenario contained the medical topics of haematology, gastroenterology, and neurology. They were not matched to any particular clinician's speciality. The scenarios were given to three actors (the patients) who had also been given a medical and personal history that were matched to each of the medical topics. After reading the scenario the clinicians interviewed each 'actor' to establish a medical history. They were then asked to think aloud and formulate a diagnosis. The responses were recorded and transcribed into written data and coded using a protocol analysis.

Elstein et al., (1978) described the clinicians' diagnostic reasoning model as a process which consisted of generating and testing hypotheses. The process began with the collection of data (signs and symptoms). Selected inferences were then drawn from this data and a provisional hypothesis generated. Early hypothesis generation is central to the model and results indicated that the process of hypothesis activation commenced 10% of the way into the clinicians' diagnostic reasoning (Elstein et al., 1978). The hypotheses then guided subsequent searches for more information to assist in formulating the problem. Throughout the hypotheses generation stage, clinicians were found to be continually interpreting then testing the accuracy of their hypotheses interpretation.

The results indicated there were no statistical differences between the thoroughness of data collection and the accuracy of data interpretation (Elstein et al., 1978; Elstein, Shulman and Sprafka 1990; Elstein and Schwartz, 2000). It was established that the evaluation process relied on matching the hypothesis with the clinicians' discipline knowledge in order to make accurate decisions. The evaluation stage was the critical element in the reasoning process because it highlighted the differences in reasoning between the experienced and less experienced clinicians. The experienced clinician's substantial discipline knowledge was used to generate and test hypotheses leading to diagnostic accuracy. For the less experienced clinicians limited discipline knowledge often led to an incorrect diagnosis.

These results however do not adequately account for the differences between a successful or unsuccessful problem solving strategy. The clinicians with more prior knowledge and experience were more accomplished. Prior knowledge was identified as the differentiating factor between the clinicians rather than their reasoning strategy (Elstein, 2000; Elstein et al., 1978; Elstein, Shulman, and Sprafka, 1990; Newell and Simon, 1972). Elstein and colleagues (1978) concluded it is not the quantity but the quality of knowledge used in the generation of hypotheses that differentiates the expert from the non-expert clinicians.

From this study Elstein and his colleagues formulated the following set of sequential reasoning processes:

- 1) data identification or sometimes described as the cue acquisition stage (the clinical signs and symptoms);
- 2) hypothesis generation,
- 3) information gathering;
- 4) problem reformulation; and
- 5) hypothesis evaluation (Elstein et al., 1978; Elstien, 1992).

This sequence of reasoning processes is the hypothetico-deductive model.

The result of the work of Elstein and his colleagues was the impetus for a shift in the direction of research in this field towards the importance of clinicians' prior knowledge. The focus shifted from an emphasis on individuals' reasoning processes to the role of prior knowledge in the reasoning processes (Elstein et al., 1978; Elstein et al., 1990; Elstein, 1992; Norman, 1988; Patel and Arocha, 2000). Previous research in this area was dominated by general reasoning strategies and abilities, undervaluing the role of knowledge and experience (de Groot, 1965; Kassirer and Gorry, 1978; Newell and Simon, 1972; Simon and Simon, 1978). The shift began by recognising the significance of clinicians' knowledge base in the reasoning process because little attention had been given to the role of knowledge and clinical practice experiences.

Studies subsequently focused on systematically identifying the relationship between the role of individuals' knowledge and their practice experience in the reasoning process at various levels of expertise (Elstein et al., 1990). At the same time, as the direction of the role of knowledge in expert reasoning research began to change, there was a rapid growth in the understanding of the human body systems and functions (pathophysiology). This knowledge became a theme in future research and clinicians began to take an active role in this area of research.

The next phase of studies involved interviewing expert medical and nursing clinicians in order to identify and understand their clinical reasoning strategies and clarify the role of knowledge in the process. The first study reviewed medical experts' clinical reasoning processes, examining the types of hypotheses they generated (Patel and Groen, 1986).

Expert Medical Clinicians' Reasoning Strategies

To distinguish the reasoning process when generating and testing hypothesis in the hypothetico-deductive model, seven cardiologists (expert medical clinicians) were given a complicated case of acute infectious endocarditis to diagnose (Patel and Groen, 1986). The case scenario was within the domain of a cardiologist's expertise but was an atypical case, and difficult to diagnose because the patient showed signs of acute infection (serious) with aortic heart valve involvement. A typical case of sub-acute or not serious endocarditis usually occurs when the mitral heart valve is affected. The cardiologists were given 2.5 minutes to read the case, and were then asked to recall all case information in writing and to use this information to describe the underlying pathophysiology associated with the case to structure their diagnosis. A propositional analysis was used to examine the clinicians' reasoning protocols and if they were completely hypothesis driven in a forward reasoning or backward reasoning process, or a mixture of both.

Four of the seven cardiologists gave a correct diagnosis and three gave an incorrect diagnosis. The successful clinicians generated their hypothesis early in the reasoning process and were readily able to discriminate between relevant and irrelevant information. This type of reasoning is an example of a forward reasoning strategy (from data to solution), and leads to an immediate representation of the problem. The diagnosis was reasoned through a set of decision rules in the 'if → then' format (Patel and Groen, 1986). Once the hypothesis is generated, the rules apply in a deductive process to test the hypothesis. A diagnostic conclusion was based on the matched clinical items (data cues) of the patient data (if → indicator) to the inference made (then → a consequence). In other words, if 'this' then 'that' was the result. Patel and Groen described this causal rule as 'if infection, then fever' which implies a conditional rule 'if fever then infection' was the consequence.

The successful cardiologists were found to rely on their clinical experience and prior pathophysiology knowledge rather than the information in the recall text. They used disease related causal pattern rules to guide their correct diagnoses, and minimal causal knowledge to yield accurate diagnoses which Patel and Groen (1986), described as canonical (accepted) knowledge.

The three cardiologists who gave an incorrect diagnosis used a backward reasoning strategy (from tentative solution to the data). Backward reasoning is frequently linked to

unsuccessful problem solutions (Ericsson and Charness, 1994; Patel et al., 1990). Patel and Groen (1986) indicated that the clinicians' incorrect diagnosis was possibly the result of the study itself. The authors noted that clinicians are trained to reason clinical situations and further information can be collected from a patient to confirm or reject their diagnostic hypotheses, which is not available in an experiment. These circumstances rather than the clinicians' reasoning strategy, accounted for the cardiologists' incorrect diagnosis.

In the Patel and Groen (1986) study, the experienced clinicians who made accurate diagnoses used a forward reasoning process. However those who made inaccurate diagnoses used a backward reasoning. To account for the differences in reasoning Patel and Groen indicated that the use of a system of rules generated a diagnostic explanation and these rules are the causal patterns represented in prior knowledge structured in disease patterns. The successful experts' reasoning was based on their prior knowledge and not on the use of the hypothetico-deductive model. How their knowledge develops and how it is accessed is not adequately explained in the study, but Patel and Groen suggested that the integration of clinicians' text based (declarative) knowledge and clinical experiences (procedural knowledge) would generate the rules, or a schema of networked knowledge (1986). The study explored medical clinicians' reasoning strategies and to further understand these processes, an examination of the use of the hypothetico-deductive model by expert nurses when reasoning care is reviewed next.

Expert Nurses' Reasoning Strategies

Fowler's (1994 and 1997) studies examined the reasoning strategies of five experienced home health nurses as they prepared a care plan for two of their chronically ill patients. Data were collected from the nurses in two interviews. The first interview was scheduled prior to meeting each patient and the second immediately after the home visit. During the interviews the nurses were asked to think aloud as they planned care for the pre-home visit, and following the visit were asked to review their initial plan after assessing the patient and modifying it where necessary. Both interviews were recorded and later transcribed for content analysis.

Results indicated that the reasoning processes of the experienced nurses used the framework of the hypothetico-deductive model (Elstein et al., 1978) in the preparation of their care plan. The nurses formulated their hypotheses on receipt of a patient referral form. For example, in the case of a 72 year old man with neurological defects, the nurses' pre-

visit plan collected important data cues to assess his behaviour and conversation. The data cues were an overview of his day to day living skills, his ability to problem solve and whether he interacted with the outside world or was locked inside himself. This information, combined with case notes and the nurses' prior knowledge and experience, guided the development of an initial care plan (Fowler, 1994).

After the home visit, the pre-visit plan was evaluated and with these details a post-visit plan was developed. Data from the home visit explained how '*...the actual home was a lot more complex and comprehensive than I would have thought...I was sorta blown away by the acuteness and suddenness of someone going from independence to total care in three weeks' time*'. The nurse also reviewed his wife's situation and hypothesised that '*...she is gonna (sic) have a lot of stress problems. So I think the whole system of support needs to be activated – social work, counselling, we need to get some help for her*' (Fowler, 1997, p. 355 and 6). The example of this patient's pre and post care plan illustrated how the experienced nurses used a hypothetico-deductive model in their reasoning (Elstein et al., 1978). The experienced nurses' pre visit plan began with the generation of the hypothesis via the hospital referral form. On gathering further information after visiting the patient's home, the plan was evaluated and the provisional plan was modified to accommodate new concepts (65%) identified after the post visit.

The reasoning knowledge of the experienced nurses was discipline specific and it was evident from the findings that their prior knowledge and past experiences of similar cases were used to confirm or refute relevance to each hypothesis generated. Fowler (1997) called this their experiential knowledge or what Patel and Groen (1986) had referred to as canonical knowledge, which became structured through increasing practice experience, and accounts for experienced clinicians' practice (Fowler, 1994; Fowler, 1997; Patel and Groen, 1986). Relevance of their discipline specific knowledge and the interrelationship between experienced clinicians' prior knowledge and clinical experiences appears to be linked to efficient and successful reasoning of their clinical decisions.

In the next study the decision making processes of nurse and medical clinicians working in a common practice setting are examined to explore differences, if any; and to explore the possibility that their knowledge of the tasks may influence the reasoning processes and subsequent outcomes.

Offredy's (2002) study examined the differences in the discipline knowledge and decision making between 11 nurse practitioners (NPs) and 11 general medical practitioners (GPs). The registered nurses in the study had completed a NP's degree program, which included decision making modules, and they had varying levels of experience working alongside doctors in a primary health care facility. The NPs and GPs were asked to make a diagnosis and provide treatment options for six cases common in their primary care practice. The six case scenarios consisted of:

- 1) a patient with a rash (shingles);
- 2) an unhealed wound to the cheek (cigarette burn);
- 3) back pain (lower);
- 4) a persistent cough (chest infection);
- 5) vaginal discharge (pelvic inflammatory disease); and
- 6) a patient with hypertension.

The NPs and GPs were given the details of each patient (age, and their illness symptoms) and then asked to think aloud while making a diagnosis and planning the treatment required. The responses were recorded and transcribed for protocol analysis. The results indicated that there were more similarities than differences between NPs and GPs in their ability to identify relevant information. The differences were attributed to the GPs' experience and their more sophisticated discipline specific knowledge. The GPs' ability to interpret data cues (signs and symptoms) and 'chunk' common sets of information together resulted in fewer data driven hypotheses, which in turn allowed them to reason and make faster decisions that led to accurate diagnoses, compared to those of NPs. For example in the cue acquisition (information gathering) process the number of critical and relevant cues selected by GPs was 620, compared with 701 from the NPs. Offredy found GPs and NPs used a hypothetico-deductive model framework in their reasoning. However, the findings accounted for a further four processes used by the GPs and NPs which were:

- 1) their therapeutic decisions concerning patient diagnosis;
- 2) the treatment given;
- 3) advice given; and
- 4) further treatment or advice or referral to another.

Differences between the GPs and NPs were attributed to the NPs' training in decision making and their levels of prior knowledge and experiences. The NPs were not novice

nurses; however some were more experienced than others working across disciplines with the GPs. Even though there were some knowledge overlaps, there was a distinction between generic and specific medical knowledge (Offredy, 2002; Patel and Groen, 1991).

The results identified different characteristics in knowledge structure between GPs and NPs. The GPs' knowledge was relevant, accessible and stored in memory as structured patterns of disease information. Offredy suggested it is similar to the pattern recognition method of reasoning using experience of past cases (2002). However the success of experienced clinicians' reasoning outcomes is not simply explained by their reasoning and diagnostic ability as first thought by Offredy, but also relied on the individual's prior knowledge and practice experience. This study highlighted the importance of the role of discipline specific prior knowledge.

Studies by Fowler (1997) and Patel and Groen (1991) also highlighted that the role of discipline specific prior knowledge was important in the reasoning processes of experienced clinicians. Fowler (1997), Offredy (2002) and Patel and Groen (1991) identified the role of discipline specific prior knowledge in the reasoning processes of experienced clinicians. However the differences between levels of expertise were not examined. Therefore an examination of the role of knowledge in the diagnostic reasoning processes of nurses at different levels of expertise is reviewed in the next study and may provide some insight into differences in the structure of their knowledge.

Nursing Students and Experienced Nurses' Reasoning Strategies

The reasoning processes and diagnostic strategies of 43 nurse clinicians were examined for similarities with the medical clinicians' hypothetico-deductive reasoning model (Putzier et al., 1985; Westfall, Tanner, Padrick, and Putzier, 1986; Tanner et al., 1987). The nurses were divided into three groups according to their expertise; there were 15 junior (first year) and 13 senior (final year) student nurses, and 15 practicing nurses (with a minimum of two years' experience).

The students and nurses were presented with three case scenarios:

1. a recurrent malignant histiocytoma on the right lateral thigh with the patient showing signs of increasing weakness and loss of appetite;

2. a patient with chronic obstructive lung disease showing signs of an increased shortness of breath, sudden weight gain and decreasing self-care; and
3. a patient with undiagnosed abdominal pain associated with a history of diabetes mellitus.

The three case scenarios were given to the students and nurses, in the form of a shift change report containing the patient's age, medical details and any complications. This was then followed by three videotaped vignettes of the patients' signs and symptoms and finally with three sets of health data to review. The students and nurses' were then asked to think aloud to identify the problem in each case and formulate a nursing management plan and were given 20 minutes to complete each simulation. The interviews were audio taped and later transcribed for protocol analysis. There were three sets of analyses which were reported in three separate papers (Putzier et al., 1985; Westfall et al., 1986; Tanner et al., 1987).

In the first paper Putzier and colleagues (1985) reported the first clinical case scenario (recurrent malignant histiocytoma) and a possible application of the hypothetico-deductive model framework in their diagnostic reasoning. The students and nurses' data protocols were compared with the categories of hypothesis activation, data acquisition and hypothesis evaluation from the hypothetico-deductive model.

The results indicated that both students' and nurses' reasoning strategies used four categories of the model in the formulation of their diagnosis:

1. a cue based approach. This approach sought single cues and in sequence;
2. in an hypothesis driven approach in attempts to rule in or rule out the specific hypothesis;
3. systematic data collection was used by the head to toe analysis; and
4. a shotgun or hit or miss approach (used by the student nurses).

Each group activated at least one hypothesis and most importantly, early hypothesis generation was prominent in the reasoning processes in all groups (Elstein et al., 1978; Greenwood, 1998; Putzier et al., 1985; Tanner, 1998).

In the second paper, Westfall and colleagues (1986) reported the second case scenario (undiagnosed abdominal pain) by examining the nature of the hypotheses generated in the students' and nurses' data protocols. In order to account for the differences between the students' and the nurses' reasoning strategies data were examined and coded for:

- 1) the number of generated hypotheses;
- 2) the comprehensiveness of the hypotheses to measure the proportion of accurate and plausible hypotheses;
- 3) the quantity of accurate hypotheses generated;
- 4) the total number of diagnostic hypotheses generated against the total number of accurate and plausible hypotheses;
- 5) the complexity of the generated hypotheses by the proportion of indirect hypotheses generated to score the direct and indirect hypotheses; and
- 6) the proportion of hypotheses generated in the first half of data verbalisation to the total number of hypotheses.

As a result data were coded for six types of hypothesis generation – accurate hypotheses, plausible hypotheses, implausible hypotheses, related hypotheses, nursing inferences and other inferences.

No significant differences between the junior (first year) and senior (final year) student nurses, and the practicing nurses were found in the number of hypotheses activated, their comprehensiveness, their efficiency or proficiency scores. All groups activated the majority of their inferences early in the diagnostic reasoning process. Practicing nurses activated complex inferences significantly more than the two groups of student nurses. This suggests that the experienced nurses had better access to their prior knowledge than the students (Westfall et al., 1986). The nurses (with their two years minimum practice experience) had developed a structured discipline specific knowledge that enabled them to reason accurate decisions.

In the third paper Tanner and colleagues (1987) examined differences between the quantity of task knowledge and the problem solving elements used by the three groups of nurses with varying levels of expertise based on the three case scenarios (recurrent malignant histiocytoma, a chronic obstructive lung disease and undiagnosed abdominal pain). The students' and nurses' verbal protocol data were coded to identify:

- 1) hypothesis activation, for the number of accurate or a possible but inaccurate hypotheses;
- 2) data acquisition, by the five strategies of cue based, hypothesis driven, systems review, question answer, or a random approach and scored by the number of questions asked by the students and nurses, and their reasoning strategy;
- 3) rejection or acceptance of the hypothesis and scored by the number of accurate diagnoses.

The results highlighted that diagnostic accuracy was found in all groups' data and across all three cases. Across all the cases the students and nurses activated their hypotheses early in the process and applied systematic data gathering to test the hypotheses. All groups' data acquisition strategies were cue based (95%) and hypothesis driven (91%). However, the more experienced nurses used their prior knowledge to systematically gather data and test their hypotheses. They processed links between context specific and task knowledge, which resulted in the generation of accurate diagnostic hypotheses (Tanner et al., 1987; Westfall et al., 1986).

The experienced nurses considered the diagnostic and judgment possibilities very early in the reasoning process – a finding consistent with a number of other studies (Elstein et al., 1978; Kassirer and Gorry, 1978; Putzier et al., 1985; Tanner et al., 1987). The junior student nurses formulated their hypotheses early in the task and used the case scenario information to gather cue data and confirm or eliminate their hypotheses. The senior students asked significantly more clarifying questions to confirm their hypotheses than the junior students and experienced nurses. No significant differences were found between the students' and nurses' reasoning processes across all three clinical case scenarios. This was an unexpected finding because Tanner and colleagues expected the reasoning processes should have differed markedly given the different levels of students and nurses' expertise. While the reasoning processes were not different, the experienced nurses were found to be more systematic in gathering their data, compared to the student nurses.

The reasoning processes and diagnostic strategies of the 43 nurse clinicians in this study were found to incorporate similar characteristics to medical clinicians' reasoning (Elstein et al., 1978; Putzier et al., 1985; Westfall et al., 1986; Tanner et al., 1987). The activation of diagnostic hypotheses early in the process and the systematic gathering of information to rule in and rule out a hypothesis were similar. However there were differences between the

three levels of expertise in the complexity of the hypotheses generated (Tanner et al., 1987). The experienced nurses were able to reason complex cases accurately because they had more prior knowledge and experience to call upon than the less experienced student nurses. There were differences between the two student groups; the senior students asked more clarifying questions when confirming their hypotheses than the junior students. The researchers did not refer to how the specific task knowledge develops, was linked with past experiences or how it was used in reasoning clinical problems. This study does identify that nurses with varying levels of expertise use their knowledge differently and confirms an individual's knowledge and experiences are important in the development of a discipline specific structured knowledge base. The role of knowledge and the complexity of a task are examined in the next study which looks at two levels of nurses' discipline specific knowledge used to reason complex nursing tasks.

Corcoran's study examined the difference between the task complexity and the nursing expertise of six experienced and five novice registered nurses as they planned the care for hospice patients and the study is reported in two papers (Corcoran, 1986a; Corcoran, 1986b). The nurses were given three written case scenarios of patients with severe chronic pain, each at different levels of complexity (one high, one medium and one low). The nurses were asked to think aloud as they formulated a plan to control the patient's pain and prepare a written pain control care plan. The nurses' responses were recorded and later transcribed for analysis.

The levels of complexity of each case were coded for:

- 1) the type (could be drug or non-drug) and number of the pain related actions taken;
- 2) the number and quality of alternate actions and the sequence of evaluated alternate actions; and
- 3) the quality of the final care plans that contained data consistent with the plan, appropriate data although not consistent with the plan, or not appropriate and erroneous (Corcoran, 1986a; Corcoran, 1986b).

The results indicated experienced hospice nurses generated more detailed drug alternatives than the novice hospice nurses. The number of alternate actions generated by the experienced nurses was highest in the high complex case (20) and lowest in the least complex case (12) compared to the novices. The novice generated less alternate actions in

the high complex case (12) and the least in the complex case (9). To illustrate the difference between the nurses an experienced nurse described how she would '*...talk about his abdominal pain – to explain the gate theory to him so he has some basis for helping to make decisions about his own regimen*' and in contrast the novice simply stated '*...I would talk with him*' (Corcoran, 1986a P.159). In this example the difference between the experienced nurse and the novice was attributed to the experienced nurse's knowledge of the physiology of pain which enabled the experienced nurse to give the person a rationale for his care. On the other hand the novice nurse did not give a rationale to the person which would indicate limited understanding of the patient's needs.

Evaluation of the actions of the experienced and the novice nurse was measured by the total number of alternative actions taken by the acceptance or rejection of a statement. For example, '*I would use...because*' or '*I would not try it*' (Corcoran, 1986a p.159). Corcoran found all nurses evaluated their actions as they were generated. The experts provided a more detailed rationale in their evaluations, for example, when deciding to reject methadone as a treatment a nurse wrote '*...methadone is sometimes a consideration for people who have problems with morphine. But with someone like this ...already with problems with mental clarity...I wouldn't try (it)*'. The novice on the other hand wrote '*...I know we usually use methadone for older debilitated persons, but I don't know why. I guess I would use it here*' (Corcoran, 1986a p.159).

There were seven consistent and appropriate pain control care plans in the low complex case with four incomplete or erroneous care plans. In the moderately complex case there were four quality care plans with seven incomplete or erroneous care plans. In the high complexity case there were eight, with three incomplete or erroneous care plans. Corcoran noted that the experienced nurses did generate more comprehensive plans in the high complexity case.

The experienced nurses were found to employ a broader clinical approach in their care plans by integrating all accessible information, and they generated more options for drug alternatives which included collaborating with all the health professionals. The nurses were able to evaluate all the alternates available to them and provided a rationale for their reasoning and decisions which represented a sophisticated discipline specific knowledge and led to the generation of quality plans.

On the other hand novices had some difficulties with the development of a care plan. Their approach to planning was narrow because they focused mainly on single cues, which often led to poorly designed, incomplete or erroneous plans. The incomplete or erroneous pain control care plans were caused by a failure to identify the major source of the person's pain and identify alternate drug options. This resulted in poor pain control for the patient. The frequent focus on one cue and the inability to develop alternate actions was attributed by Corcoran to their lack of discipline specific knowledge (Corcoran, 1986a).

The differences between experts' and novices' care planning in Corcoran's study may be explained by the quantity and quality of their discipline specific knowledge. The quality of pain control care plan of the experienced hospice nurses was superior to those of the novices. Corcoran identified that all nurses used two types of knowledge in the formation of their pain control care plan, the declarative (factual) knowledge and procedural (task or skills of a discipline) knowledge. The experienced nurses' verbalisations however highlighted the use of their conditional knowledge (Corcoran, 1986a; Corcoran 1986b).

The experienced nurses had grouped together their knowledge of pain relief drugs in a categorical form of an 'analgesic ladder'. This analgesic ladder reduced the 'cognitive strain' on their short term memory and allowed them access to information effectively because of this structured knowledge of pain relief drugs held in their long term memory (Corcoran, 1986b). The ladder provided steps of drug treatments to match specific data cues (symptoms) and as a consequence made the drugs easier to recall when planning patient care (Corcoran, 1986b). For example, the expert nurses explained '*...keep it chemically simple*' and reasoned '*...it is better to increase the dosage than increase the frequency of the drug*' (Corcoran 1986b p. 39).

The complexity of a task places demands on nurses' knowledge and they reduce these demands by employing a condition-action rule of thumb, for example '*...the patient has had, or might have expected, side effects from a primary therapy, so consider a therapy to control the side effect*' (p. 39). The experienced hospice nurses established their readily assessable prior knowledge of pain control by using their conditional knowledge, which is a sophisticated knowledge structure (Corcoran, 1986a; Corcoran, 1986b).

Corcoran's study provided evidence that a structured knowledge base is necessary to inform reasoning decisions in complex situations. The experienced nurses verbalised what knowledge they used, how it was structured and how they made use of that knowledge. By

contrast the novices' verbalisations did not demonstrate how they used knowledge and how it is structured.

Summary of Hypothetico-Deductive Model

It appears from studies reviewed in the hypothetico-deductive model of reasoning clinical problems that the sequence of data identification, hypothesis generation, information gathering and hypothesis evaluation explained experienced clinicians' diagnostic reasoning processes. Novice and experienced clinicians were found to use a process of hypotheses generation in reasoning clinical decisions. However experts' diagnostic outcomes were more accurate because the role of prior knowledge and its relationship with data cues influenced the quality of the hypothesis generated (Corcoran, 1986a; Corcoran, 1986b; Offredy, 2002).

Corcoran, (1986a and 1986b) defined knowledge as declarative knowledge (formal factual and domain specific knowledge) and procedural knowledge (the practice skills) and conditional knowledge. An important finding from the studies was that the quality of the hypotheses generated by the experienced nurses linked with their prior knowledge and clinical experiences in the hospice setting. The studies provided evidence that clinicians' integrated prior knowledge and clinical experiences had developed into schemas of networked discipline knowledge (Fowler, 1997; Patel and Groen, 1986).

Overall the results from these studies identified the differences in the nature of knowledge between levels of expertise. While the hypothetico-deductive model was found to be inadequate in distinguishing between experienced and novice reasoning processes there were differences in the accuracy of diagnostic outcomes. Successful diagnostic outcome relies on the clinicians' discipline specific knowledge.

To understand how a discipline specific knowledge base develops and links with clinical practice experience one needs those studies that examine the character of prior knowledge, the structure of knowledge and the use of knowledge in reasoning clinical problems. Midwifery studies examining the role and structure of midwives' knowledge appear to be limited and largely informed by the disciplines of medicine and nursing (Mok and Stevens, 2005). The next section will review the medical and nursing literature with specific reference to the role of knowledge in reasoning clinical decisions in the knowledge-driven models.

Knowledge Driven Models

The focus of a knowledge driven model is on the structure and availability of knowledge stored in memory as the significant component in diagnostic thinking and practice. Studies that examine the role of individual's prior knowledge, (Balla et al., 1990; Patel, Groen and Scott, 1988), its structure and use in the reasoning process (Boshuizen and Schmidt, 1992; Cioffi and Markham, 1997; Grant and Marsden, 1987; Grant and Marsden, 1988; Schmidt and Boshuizen, 1993) are reviewed next.

The Role of Prior Knowledge in Clinical Reasoning

The role of medical students' prior knowledge is examined in two studies. In the first study the development and role of basic science (declarative) knowledge used in reasoning by students in three levels of expertise are examined (Patel et al., 1988). The second study examined the use of medical students' basic science (declarative) knowledge in reasoning (Balla et al., 1990). Students in the Balla and colleagues' study were at the same level of expertise.

Patel and colleagues studied 24 medical students who were divided into three groups according to their level of expertise and knowledge, eight were first year students with little theory knowledge and no clinical practice experience, eight were in their second year as students with some theory knowledge, but no clinical experience; and eight were final year students with theory knowledge and experience. The aim of the study was to examine the role of students' basic science (declarative) knowledge when reasoning a clinical task (Patel et al., 1988).

Students were first given three basic science texts to read. The texts covered the physiology topics of fever, haemodynamics and microcirculation and after reading the text they were then asked to recall each topic in writing. In a second session students were given a clinical case scenario of a patient with acute bacterial endocarditis to read and then asked to write a diagnosis explaining the underlying pathophysiology associated with the case.

Propositional analysis techniques were used to examine the students' data and identify the underlying pathophysiology related to each of the propositions in the case (Patel et al., 1988). To assess the students' diagnostic accuracy the researchers applied two types of propositional rules to data segments, *causal* (leading away from a diagnosis) and *condition*

(leading to a diagnosis). These rules were applied to the students' data in the form of the following clinical categories:

- 1) infection-fever;
- 2) aortic insufficiency;
- 3) embolic phenomena; and
- 4) acuteness of the disease of bacterial endocarditis (Patel et al., 1988).

Diagnostic accuracy was dependent upon an understanding of the disease process and the ability to connect the various pathophysiological disease components.

The results for all levels of students in their use of basic science information (propositions) and the explanation of their underlying pathology of the clinical case were in general relatively poor. The recall of the basic science text was higher in the second and the fourth year students' data than for that of the first year students.

There was very little difference in knowledge of the underlying pathophysiology of the case amongst the students, with the exception of the fever topic which scored the highest in all groups' results. For example, in the pathophysiology knowledge underlying the fever topic the first year students scored higher ($m=31.3$) than second and final year students ($m=17.5$ and $m=17.3$ respectively); in the haemodynamics knowledge topic the first year students scored higher than second ($m=6.3$ and $m=3.5$ respectively) and lower than final year students ($m=9.3$); and in the microcirculation knowledge topic the first year students scored higher than second ($m=6.3$ and $m=1.8$ respectively) and slightly lower than final year students ($m=6.7$).

These results show that students do not use the pathophysiology information at the detailed level that it is taught in order to reason cases. Patel and colleagues described the students' reasoning as being characterised by the use of generalised rules (or rules of thumb) from prior knowledge. The first year students, finding the text too technical, used their common sense experiential knowledge, while the second year students used additional basic science information not provided in the text but covered in their course work. However, their use of causal rules was often found to be contradictory or incorrect (Patel et al., 1988). The final year students used more clinically based information. They were able to rationalise their diagnosis by the general causal rule that infection causes fever; and infection leads to a high blood flow situation which causes the heart murmur by virtue of the flow turbulence.

The final year students displayed a level of discipline knowledge and reasoning skill similar to that of an experienced clinician reasoning outside their discipline. All three student groups used information compatible with their level of expertise.

Patel and colleagues concluded that students with basic science knowledge but no clinical experience introduced far more rules into the explanations but failed to establish patterns of relations or to use information selectively. The students with both science knowledge and clinical experience seemed able to identify both global patterns of relations and use available information selectively in generating diagnostic explanations. The relationship between the role of prior knowledge and the diagnostic accuracy of students at the same level of expertise is examined in more detail in the second study.

Balla and colleagues (1990) investigated the relationship between 150 medical students' prior knowledge and diagnostic accuracy during the second year of their anatomy course. The aim of the study was to explore the relationship between the use of prior knowledge in their diagnostic reasoning. The students' prior knowledge consisted of lectures on the anatomy and basic physiology of the nervous system and the practical experience of the anatomical dissection of a body. The students viewed a videotape of a patient with a neurological problem. After viewing the videotape the students were asked to write a diagnosis (time allotted was eight minutes) and to explain how they came to the diagnosis. The students were then given an anatomy question to answer (time allotted ten minutes).

Their written responses to the neurological problem were scored using four categories:

- 1) no diagnosis;
- 2) wrong diagnosis;
- 3) a reasonable understanding of the principles of clinical neuroanatomy; a
- 4) correct diagnosis.

The explanations of their diagnoses were also scored for structural complexity used The Structure of the Observed Learning Outcomes (SOLO) taxonomy in five levels of understanding identified as pre-structural, uni-structural, multi-structural, relational and extended abstract (see Appendix 5 for a description of all SOLO levels of understanding) (Biggs and Collis; 1989). The students' diagnoses were scored for correct interpretation or wrong interpretation. The answers to the anatomy question were compared with a model answer and scored for the correct or incorrect answer.

Balla and colleagues (1990) predicted that there would be a direct relationship between the correct diagnosis and students' prior knowledge. However, the results indicated that students' level of understanding varied and this was reflected in explanations contained in their diagnoses. The following five examples reflect students' different levels of understanding when reasoning a diagnosis.

Student A's diagnosis is based on irrelevant information (*...the lesion may be due to the pressure damage of nerves when she fell down*) and represents a pre-structural level of understanding.

Student B used one item of relevant information in the diagnosis (*...clumsy movement of right hand. Weakness causing the patient difficulty lifting heavy objects, nor can she control a pair of chopsticks delicately. The patient cannot use her right hand to bring objects to her face correctly*), the one relevant feature supporting the students' diagnoses was recognising the patient's uncoordinated behaviour, a uni-structural level of understanding. However the student was unable to identify the clinical abnormality related to the cerebella and to link its function with other higher centres of the brain control.

Student C's response was based on several items of relevant information that linked to their diagnosis (*...since she could move her hands, there must not be a problem with the muscle...//...(or) the peripheral nerve. She could not handle delicate things or do something that required coordination movement. So must be something wrong with the motor area or maybe the spinal cord or C7-T1*) signified the multi-structural level of understanding. This student was able to explain the relationship between the observed data cues and anatomy contributing to the possibility of a higher centre lesion diagnosis.

Student D's diagnosis (*...because she has difficulty in coordination the movement of her right upper limb*) and goes on to rationalise why (*...voluntary movements can still be achieved, and she did not complain about loss of sensation on the right upper limb. She may not have a lesion in the motor cortex of the cerebrum since she has no difficulty in initiating movement so the basal ganglia are also spared. Therefore it should be a lesion of the right cerebellum which controls the coordination of movement on the ipsilateral side of the body*) demonstrates a relational level of understanding. Data cues were linked with this student's prior knowledge which had led to a reasoning that excluded a motor cortex lesion extending and discussed other neurological pathways associated with data cues towards the diagnosis.

The extended abstract level of understanding responses is based on the use of all available information to form a hypothesis based on high level principles and a highly developed knowledge structure. No students' responses were categorised at the extended abstract level.

The relation between the students' diagnoses and SOLO level results indicated no correct diagnosis in the pre structural level of understanding. The students who reached the uni-structural levels of understanding made some tentative diagnoses using their basic science (declarative) knowledge. Those who reached the multi-structural level of understanding were the most likely to make the most accurate diagnostic responses even though basic science (declarative) knowledge was accessible in a list-like presentation with no formal linkage. The students' limited quality knowledge led to the misinterpretations of the clinical data cues and therefore they were less likely to make correct diagnoses. Some had structured their prior knowledge and reached the relational level of understanding and were able to link their prior knowledge to the case and make a correct diagnosis but no student reached the extended abstract level of understanding. These results were not surprising given the limited exposure of the students to the clinical setting (Balla et al., 1990).

The results of the students' anatomy question demonstrated that all students had a basic understanding of anatomical (declarative) knowledge concepts but these concepts were not linked with clinical knowledge. No evidence of a link between anatomy knowledge and correct diagnosis was found in these results (Balla et al., 1990). The students' basic (declarative) knowledge structure and clinical practice knowledge structure formed more or less independently of each other. This finding is consistent with Patel and colleagues' study of students' knowledge development (1988).

The most important finding from the study of Balla and colleagues (1990) was the relationship between the structure of students' prior knowledge and diagnostic accuracy. Even though all students were at the same stage in their program of learning, their knowledge structures varied. The individual differences in their knowledge development were demonstrated in the SOLO levels of understanding. This suggested that the individual differences in knowledge development are influenced by clinical practice experiences. The studies of Balla et al., (1990) and Patel et al., (1988) highlighted difference in the structure

of medical students' prior knowledge and how the quality of this knowledge is linked with accurate diagnosis.

To further investigate the links in the chain of knowledge development, the structure of prior knowledge and its relationship to reasoning accurate outcomes are examined next. The studies examine medical students and clinicians with varying levels of expertise.

The Structure of Knowledge in the Reasoning Process

The concept of 'forceful features' was introduced by Gale, (1982) and Gale and Marsden, (1982) to describe the critical variables in diagnostic thinking and reasoning of medical students and experienced clinicians (Grant and Marsden, 1987). Forceful features are defined as important and meaningful pieces of information that act as the key to memory structures. The use of the forceful features is the focus of Grant and Marsden's (1987) study that examined differences in the knowledge structures of 75 medical students and clinicians in five levels of expertise, with 15 in each group. Groups consisted of first year medical students, third year medical students, house physicians, medical registrars and consultants working within general medicine.

The students and clinicians were presented with four written case scenarios, two classified as straight-forward case histories (inguinal hernia and irritable bowel syndrome), and two classified as more complicated case histories (occult alcoholic cirrhosis and hypertrophic pulmonary osteo-arthritis). After reading the scenarios the students and clinicians were then asked to give at least five diagnostic interpretations for each case and identify the item(s) of information (forceful features) that informed their interpretations. The analysis compared all groups' diagnostic interpretations and the forceful features to identify the differences in their memory structures.

In all cases the number of different forceful features identified across groups was lower when compared to the number of diagnostic interpretations. The results indicated there was no significant difference between groups in the number of diagnostic interpretations and the number of forceful features identified in each case (Grant and Marsden, 1987). At all levels of experience the breadth of thinking was the same in all cases. However, the actual diagnostic interpretations and actual forceful features identified did differ significantly across groups and in task difficulty, with fewer forceful features identified in the higher complexity cases than in the lower complexity cases. This difference in the actual content of

knowledge structure of the students, the clinicians and the consultants showed in the quality of diagnostic interpretations and their forceful features, which varied with case complexity. The content of their thinking is the distinguishing factor between individuals with different levels of expertise. This finding was not an unreasonable expectation given the range of experience levels. Grant and Marsden (1987) concluded that individuals may think in the same way, however the content of their thoughts differ and this individuality of thought content is linked to the levels of clinical expertise.

To broaden these findings further Grant and Marsden (1988) focused more specifically on the differences in clinicians' knowledge base in explaining expertise. They used an opportunistic sample of 75 medical students and clinicians in five levels of expertise (15 per group) in three groups (students, clinicians and consultants). The student group consisted of first and third year medical students; the clinician group included house physicians, medical registrars and the consultant group of clinicians working in general medicine.

All participants were given four case scenarios to read, two typical general medicine problems (Crohn's disease and myocardial infarction) and two less typical general medicine problems (epilepsy and arthritis). Each case scenario began with an introductory diagnostic sentence. For example, a man of 53 says that he suffered a myocardial infarction. They then were asked to write down all the necessary assessment questions they would ask to establish a diagnosis and to identify the diagnostic tests they would use to investigate each case (Grant and Marsden, 1988).

The results showed that the total number of assessment questions requested by all groups was high overall but varied across all four cases (first year students mean 45.3; third year students mean 70.5, physicians mean 66.3, registrars mean 76.9 and consultants mean 63.3). There was an increase in the number of assessment questions from the first to the third year students as expected as they gain more knowledge as their course progresses. The results for the house physicians (pre-registration level) were closest to third year students. The medical registrar group asked the highest number of questions which Grant and Marsden rationalised as a tendency for the use of common core knowledge to be highest immediately after clinical training and medical school. In the immediate post graduate years registrars are less able to distinguish between more important and less important assessment questions. Both the first year student and consultant groups asked the least number of assessment questions but for different reasons. Grant and Marsden (1988) concluded that the students had limited accessible knowledge to draw on, while the

experienced consultants were more selective because they used prior knowledge based on their experiences rather than using common core (declarative) knowledge.

Grant and Marsden, (1988 p.178) concluded from these findings that developmental changes

...occur in knowledge with increasing experience, therefore show a picture which begins with a narrow, idiosyncratic and inappropriate memory store, through increasing breadth and similarity to the final characteristic of a perhaps slightly narrower, useful and finely tuned primary knowledge base which has been organised to respond to the demands of clinical problems and practice.

This explanation implies that knowledge structures are formed, structured and restructured with increasing use in practice experiences and then they develop into patterns of reasoning of clinical problems. These qualitative changes in knowledge structures are individual and the more frequently knowledge is used the more sophisticated and efficient these prior knowledge structures become (Alexander, 1996).

Results from the Grant and Marsden (1988) study explained that the use of knowledge differs at varying levels of expertise during the course of learning and practice experiences. The study explored the cognitive processes that structure and restructure clinicians' knowledge. To further understand knowledge development, in particular the nature of knowledge that is actually used to solve clinical problems, the studies by Boshuizen and colleagues are reviewed next. They proposed that the development of clinical expertise and the idea that structures of knowledge are formed, structured and restructure with increasing use in practice experiences. They go on to describe that the nature of individuals' knowledge structures form and are restructured in two stages known as 'encapsulation' and 'illness scripts' (Boshuizen and Schmidt, 1992; Boshuizen et al., 1995; Schmidt and Boshuizen, 1993).

The first stage in the formation of knowledge structured networks is the encapsulation of knowledge. The process begins with learning basic details of biomedical (declarative) knowledge concepts which then begin to structure by forming direct lines between like pieces of information. With repeated application of knowledge in diagnoses and treating patients, elaborate networks of detailed concepts become encapsulated into more comprehensive clinical concepts or diagnostic labels (Boshuizen and Schmidt, 1992; Patel, Evans and Groen, 1989; van de Wiel, Boshuizen, and Schmidt, 2000). The

concepts are referred to as semi clinical diagnostic labels of semantic networks that *'...summarise a whole pathophysiological process leading to those symptoms'* (Boshuizen et al., 1995 p. 274). For example the encapsulating concepts of 'atrophy of the liver cells', an 'atypical inflammation reaction' and 'aorta-insufficiency' are the pathophysiological explanations of a blood related concept when reasoning a clinical problem that is associated with the heart or circulatory system of the body (Boshuizen and Schmidt, 1992 p.175; Schmidt and Boshuizen, 1993). These smaller numbers of higher level clinical propositions have the equivalent explanatory power in diagnostic responses, which results in the clinicians' limited use of biomedical (declarative) knowledge when reasoning clinical decisions (Patel et al., 1989).

The second stage of networked knowledge structures – 'illness scripts' – are formed as readily accessible diagnostic clinical information (Feltovich and Barrows, 1984 cited in Custers, Boshuizen and Schmidt, 1998). Illness scripts have three components. The first component is that of the 'enabling conditions' of the disease. That refers to the conditions or constraints under which the disease occurs, for example the personal, social, medical or heredity factors that may affect the course of the disease. The second component is the 'fault' which contains the pathophysiological process of the disease represented in encapsulated form. The third component consists of the 'consequences of the fault' described as the signs and symptoms of the specific disease (Boshuizen and Schmidt, 2000). The encapsulated knowledge and illness script formation develop simultaneously. Encapsulated knowledge develops and is transformed during the integration of biomedical (declarative) knowledge applied in clinical reasoning. Illness scripts are developed and formed by the clinical experiences and are described as sophisticated forms of pattern recognition of prior knowledge (Schmidt et al., 1990).

Boshuizen and Schmidt (1992) examined the idea of medical knowledge encapsulation in a two experiment study design. In the first experiment four medical clinicians with varying levels of expertise (one second year student (novice), one fourth year student (intermediate 1), one fifth year student (intermediate 2) and one clinician (the expert) with four years' experience) were presented with a clinical case scenario of chronic relapsing alcohol-induced pancreatitis. They were then asked to think aloud while studying the case notes (on 48 successive cards). All verbal data were recorded and later transcribed for analysis into verbal protocol segments.

The protocols were coded for instances of biomedical (declarative knowledge) and clinical knowledge applied to the case. Next, all general comments and statements were deleted and the remaining segments were rewritten into propositions consisting of a relation (causative) and a set of arguments. The proposition represented an argument → (relation label) then an argument. For example: appetite poor → (condition) the liver, identifying that the patient had a poor appetite which is a condition related to the liver disease. The final step in the analysis classified the propositions as biomedical (declarative) knowledge (for example the pathophysiological principle underlying the disease) or as clinical knowledge (the possible signs and symptoms of the disease) (Boshuizen and Schmidt, 1992).

Overall the number of protocols in the lower levels of expertise (pre-clinical learning levels) contained more knowledge propositions, proportionally, than the two higher levels of expertise (practical experiences). This demonstrated a shift in the use of biomedical knowledge to clinical knowledge with the increasing levels of expertise from the pre-clinical learning levels (novice and intermediate 1) and the intermediate 2, with nine months of practical experience, to the expert. Boshuizen and Schmidt, (1992) concluded that experience in practice with real patients and clinical learning influenced the developmental changes in knowledge structures. These were the important differences between the levels of expertise. Clinical knowledge is defined as understanding the manner in which a disease manifests itself in patients, involving the nature and variability of the signs and symptoms of the disease. From the results Boshuizen and Schmidt (1992) provided three hypotheses:

- 1) that individuals' biomedical (declarative) knowledge acquired and applied during the early stages of their development increases, and with increasing practice experiences over time its specific application lessens;
- 2) the more experienced clinicians' biomedical (declarative) knowledge, although inert, continues to be accessible; and
- 3) that an individual's biomedical (declarative) knowledge becomes encapsulated into higher level clinical knowledge concepts by the repeated application in the stages of expertise development.

To investigate the three hypotheses Boshuizen and Schmidt increased their sample size to 20 clinicians' at four levels of expertise (six second year students (novice), four fourth year students (intermediate 1), five fifth year students (intermediate 2) and five clinicians (experts) with four years experience). Boshuizen and Schmidt (1992) predicted that if biomedical (declarative) knowledge has become rudimentary (inaccessible) then experts

will be less able to explain the pathophysiology underlying the case (related to hypothesis one).

At the same time novices and intermediates whose biomedical (declarative) knowledge was not yet encapsulated would use fewer abbreviations when asked to explain the clinical case. If experts' knowledge becomes inert (inactive) it is not applied in explaining the clinical case, then no increase in the number of abbreviations would be expected (related to hypothesis two).

The next prediction involved that of encapsulated biomedical (declarative) knowledge. Experts would apply encapsulated knowledge in their diagnostic reasoning, and would elaborate on this encapsulated knowledge when asked to explain the case (related to hypothesis three).

The students and clinicians were given the same case scenario used in experiment one and asked to think aloud and make a diagnosis, which was recorded on audio tape and later transcribed. They were then asked to write down the underlying pathophysiological knowledge of the case. All data were coded following the same format used in the first experiment. Data were coded as biomedical knowledge and clinical knowledge segments (for example '**Observation.** Attitude: the patient sits in a chair, continually bending over or pulling up his legs; otherwise moves normally') (Boshuizen and Schmidt, 1992, p. 182). The biomedical knowledge and clinical knowledge segments were rewritten into propositions consisting of two arguments and a relation and represented as a semantic network. An example of the observation explained above '*...(interpretation) avoid contraction of his muscles → (conditional) (hypothesis) something wrong with his peritoneum → (specific) (hypothesis) beginning peritonitis → (conditional) (hypothesis) perforated peptic ulcer*' (p.184). Relationships between the matching arguments were classified by identical relation, abbreviations (a long chain of at least two propositions) or other relations. Data were analysed using a series of multi analysis of variance (MANOVA) tests.

The analysis showed an association between levels of expertise and the number of propositions (in the think aloud protocols) that explained the pathophysiological processes underlying the case. Boshuizen and Schmidt explained that the decline in experts' biomedical (declarative) knowledge applications did not result from decay in their biomedical (declarative) knowledge leading to rudimentary (inaccessible) knowledge. The

analysis of think aloud protocols with the pathophysiological explanations showed that the number of abbreviations increased with expertise. These findings confirmed that inert (inactive) biomedical (declarative) knowledge was not the result of decreasing application of biomedical (declarative) knowledge and the increase of expertise but rather knowledge formed and subsumed into higher order concepts of encapsulation (Boshuizen and Schmidt, 1992).

In order to examine the knowledge encapsulation hypothesis further Schmidt and Boshuizen (1993) conducted a two-experiment design study of 120 clinicians. The differing levels of expertise consisted of first year clinical health science students (novice); second year medical students (intermediate 1); fourth year medical students (intermediate 1); sixth year medical students (intermediate 2); and intern clinicians (two years post graduate) (expert). The five groups of 24 participants were randomly divided into three groups of eight to study the case under different time constraints.

The participants were given a booklet containing a 270 word description of an acute bacterial endocarditis case which each group was asked to study for 3.5 minutes, 1.25 minutes or 30 seconds respectively. After studying the case they were then asked to turn to the blank response sheets in the booklet and record all case information recalled, generate a diagnosis and explain the underlying pathophysiology of the case.

To determine diagnostic accuracy a weighted score according to importance (for example the term 'endocarditis' 2 was given points and 'bacterial' or 'contaminated needles' given 1 point) was given to the various elements related to the case that they had found in the data. The free recalls and pathophysiology explanations were analysed by segmenting them into propositions that contained two concepts linked by a relationship, for example causation, negotiation or specification. The number of free recall data propositions was counted. Encapsulation was determined by counting the number of high-level inferences that summarised at least two propositions. The measure of encapsulation in the pathophysiology explanations were ascertained by matching each proposition against the canonical model. The model contained sufficient biomedical and clinical knowledge underlying a set of all signs and symptoms of the case that represented differing levels of encapsulation. The number of propositions was matched to the model and then counted.

Expertise was found to be related to clinicians' diagnostic accuracy. The processing time did have an effect on diagnostic accuracy, however little evidence of difference between

groups was found. The authors suggested this was possibly due to small numbers within the groups and restricting the time available for clinicians to study the case affected the elaborateness of explanations. Schmidt and Boshuizen concluded that for first and second year students it is not simply a matter of an automatic activation of knowledge and clinical concepts as it is for expert groups, but an active process of knowledge retrieval and inference to the case that requires conscious cognitive effort.

The relationship between the number of pathophysiology explanations and the level of expertise was illustrated with an inverted U-shape curve. The number of pathophysiology explanation protocols of the less experienced (first and second year) students and expert clinicians was similar. On the other hand the advanced students (fourth and 6th year students) had a greater number and were more elaborate in detailing their biomedical (declarative) knowledge than the experts and first and second students. The advanced students were able to remember more detailed biomedical (declarative) knowledge than the experts, which Schmidt and Boshuizen described as an 'immediate effect' (1993). The immediate effect was dependent on the amount of time available for processing the clinical case description and was found to disappear because of the limited time allowed to recall details. The experts' quality explanations were shorter and confined to the case because their biomedical (declarative) knowledge had become encapsulated into clinical knowledge (Schmidt and Boshuizen, 1993).

In the second experiment, Schmidt and Boshuizen (1993) investigated the possibility that expertise was associated with a more extensive prior knowledge base. The study examined the differences in the use of quality knowledge between the more experienced clinicians and the less experienced students. There were five groups at various levels of expertise: first year health science students, second, fourth and sixth year medical students, and clinical interns. These five groups consisted of 20 students and clinicians who were asked to explain their knowledge of endocarditis within a given time frame (randomly allocated 3.5 minutes or 30 seconds). This was a knowledge activation task given prior to the case scenario. Each were then given the case scenario of bacterial endocarditis to study for 30 seconds and asked to generate a diagnosis in writing.

The data analysis and task procedures were prepared in the same manner as for experiment one above. The protocols for the two tasks (activation and diagnosis) were segmented into propositions. The numbers of propositions correctly recalled were counted for subsequent analysis.

The results from this second experiment show a relationship between diagnostic accuracy and expertise, regardless of briefing time. However for the intermediate group the longer briefing time did have an impact because the number of their propositions had increased compared to those who were allocated a shorter briefing time. Schmidt and Boshuizen (1993) concluded that the intermediate level of understanding of a clinical case is drawn from a detailed biomedical (declarative) knowledge base whereas experts' level of understanding is drawn from encapsulated knowledge and '*...is based on knowledge structures qualitatively different from those of advanced students (intermediate level 2)*' (p. 348). There was no effect for the briefing time for novices.

Boshuizen and Schmidt (1992), and Schmidt and Boshuizen (1993) concluded that the structure and quality of prior knowledge used by clinicians of varying levels of expertise, are explained through the principle of encapsulation. Encapsulation illustrated links in the chain of how the continual use of biomedical (declarative) knowledge is transformed into clinical knowledge with repeated use in clinical reasoning and diagnosing patients. The clinicians' elaborate networks of prior biomedical (declarative) knowledge become subsumed into higher level structures of clinical concepts or diagnostic labels of semantic networks of encapsulated knowledge.

The Boshuizen and Schmidt (1992), and Schmidt and Boshuizen (1993) studies illustrate how the integration of clinicians' knowledge and practice influences the development of knowledge structures and how knowledge that is stored in memory contributes to understanding the role of knowledge in reasoning clinical decisions. To further examine how this knowledge is used in the reasoning process studies from midwifery and nursing literatures are reviewed next.

The Use of Knowledge in the Reasoning Process

The reasoning strategy of the decision making process of 30 experienced midwives is examined in Cioffi and Markham's study (1997). The experts had an average of 11 years experience, and worked across teaching and district midwifery units in Australia. The midwives were presented with four simulated patient assessment tasks, two with low complexity (ante partum haemorrhage and uncomplicated established labour) and two with high complexity (a breech presentation, and a threatened premature labour). They were then asked to think aloud while they assessed each case and to research a diagnosis by asking similar assessment questions to those used in practice. All responses were audio

taped, and later transcribed for analysis. The midwives were also asked to complete a short questionnaire to rate the vividness, recentness and recall of their experiences with similar cases in their practice.

Data were arranged into protocol segments and coded by experts (two experienced midwives), who used a prepared standardised template of assessment questions and answers that represented all aspects of the four cases. The midwives' protocol segments were coded by the experienced midwives using the three heuristic principles of representativeness, availability, and anchoring and adjustment (Tversky and Kahneman, 1973). The representativeness heuristic principle applies when judging the probability that certain data cues in the case point towards patients with similar conditions based on past experiences. The basis of decisions is the extent to which patient cue patterns are more representative of experiences with previous patients or the possible risks associated with certain conditions. For example from the coded data a midwife suggested a '*...breech presentation, with the possible accompanying foetal complications*' (Cioffi and Markham, 1997 p. 266). The available heuristic principle identified the ease by which a similar condition comes to mind for the clinician. For example, a midwife's experience with '*...a particular breech birth sometime in the past, then memory of this particular case is available to be used when assessing any other patient who may be similar in some way*' (Cioffi and Markham, 1997 p. 266). The anchoring and adjustment heuristic principle identifies how the decision maker starts from a base line or anchor point and adjusts (the signs and symptoms) from this anchor point to test the hypothesis until a decision is made.

The use of two major heuristics, the representativeness, and anchoring and adjustment or the combination of the two, were identified throughout the analysis. For example, one midwife described her reasoning during the assessment of the low complexity case (uncomplicated established labour) by the woman having a '*...ovoid-shaped uterus so technically speaking the baby should be a longitudinal lie*' (representativeness). The midwife linked her prediction for the woman's labour from the history given in the case '*...gravida 7, parity 6, (therefore) probably going to be a very quick labour*' (anchoring and adjusting) (Cioffi and Markham, 1997 p. 268).

The next example describes the use of combined representativeness, and anchoring and adjustment heuristics. The midwife identified data cue '*...no increase in bleeding (with a baseline described by) half a cup of bright red blood (with a) moderately soaked pad – may have been slightly heavier than the usual show*' was coded as a representativeness

principle combined with the anchoring and adjustment principle (Cioffi & Markham, 1997 p. 268). In this case the midwife identified the data cue, argued the baseline to anchor the data cue and reasoned using her prior knowledge of the task.

The midwives in this study were found to use heuristics in their decision making. They relied on the heuristic principle of representativeness to make their judgements regardless of the complexity of the case. In their decision making there was a greater proportion in the higher complexity case than in the lower complexity cases. The representativeness heuristic was relied on more than the anchoring and adjustment, or the representativeness combined with the anchoring and adjustment heuristic types, as predicted by the authors.

The final heuristic, the availability process, demonstrated the ease by which a condition comes to mind. Prior knowledge and similarity recognition of prior experiences were found to be '*...dependent on a process of making adjustments to preconceived notions and expectations, by repeated encounters with somewhat similar practical situations*' (Cioffi and Markham, 1997 p. 271). The past experiences with patients in similar conditions form vivid patterns in nurses' memories and are drawn upon to reason when required (Cioffi, 2000; Grossman and Wheeler, 1997). The midwives reported that their memories of past experiences with uncomplicated established labour was 'very vivid' (75% of the midwives) and for only 25% in the ante partum haemorrhage of the low complexity cases. The midwives' recall of similar cases to the study's four simulated case scenarios was greater on the lower complexity cases (77%) than in the high complexity cases (57%).

The Cioffi and Markham (1997) study highlighted that experienced midwives' clinical decision making processes were found to be based on a repository of heuristics or 'short cuts' to their prior knowledge. These heuristic processes are developed from the integration of past experiences and structured knowledge and are readily accessible for making judgements and decisions. The use of these types of shortcuts estimate outcome probabilities against their prior knowledge and helps to simplify the complexity of midwives' judgments (Cioffi, 2002; Cioffi and Markham, 1997). Midwifery practice is complex, often with little certainty because patient information is usually incomplete. Therefore it is important to identify patients 'at risk' and take appropriate actions quickly, as birth tasks often preclude ample time to obtain assistance from other members of the birthing team.

Another complex clinical practice setting that has little certainty is the emergency room where nurses care for patients with a wide range of issues, often without forewarning (Cioffi, 2000). In the emergency room practice nurses are sometimes unable to resolve

their uncertainty when reasoning patient problems and rely on vivid memories of past experiences of similar cases which Cioffi described as 'holding a pattern' in their memory. Nurses do rely on their subjective judgment to reason by firstly using prior knowledge of similar situations often before searching for the objective data to support their judgment. However, when a patient is showing signs and cues of clinical deterioration and the nurse is unsure of their decision, they were then found to defer to another by calling for assistance from a Medical Emergency Team (MET).

Prior knowledge and past experiences formed in patterns of structured knowledge networks and used as a reasoning strategy are referred to as pattern recognition reasoning. As an inductive forward reasoning process, pattern recognition is characterised by matching clinical data cues to structured prior knowledge of clinical problems to reason an outcome (Azzarello, 2003; Benner and Tanner, 1987; Bucknall, 2000; Cioffi 2002; Fisher and Fonteyn, 1995; Fonteyn, Capers and Grobe, 1993; Greener, 1988; Offredy 2002). Short cuts to memory match data cues that link to patterns of prior knowledge, and reason a conclusion. This allows a reduction in the number of possibilities to consider (Cioffi and Markham, 1997) therefore reducing the complexity of decision making (de Jong and Ferguson-Hessler, 1986; Feltovich and Barrows, 1984; Tversky and Kahneman, 1973). The distinctive blend of thinking strategies in the inductive process of heuristics was found to be essential for the economy of thought and action required in an emergency department (Crookery, 2000). The use of short cuts to prior knowledge in reasoning clinical decisions has been reported in a number of different clinical studies (Benner and Tanner, 1987; Cioffi and Markham, 1997; Benner, 1984; Kassier and Kopelman, 1991; Patel et al., 1990; Pyles and Stern, 1983).

Illness scripts, mental representations, pattern recognition, and heuristic principles are terms used to describe methods of reasoning clinical problems from a structured prior knowledge base. These terms describe schematic networks of individuals' prior knowledge of specific diseases, diagnostic conditions and outcomes. With this knowledge, structured into networks by repeated experiences with similar patients in practice, clinicians are able to recognise familiar patterns of problems and search within their prior knowledge for a match, judge its value and reason the outcome. Discipline specific knowledge, structured from past experiences, explains the experienced clinician, not a novice (Boshuizen and Schmidt, 2000; Caputo and Mior, 1998; Cioffi, 2002; Cioffi and Markham, 1997; Corcoran, 1986a; Custer et al., 1998; Schmidt et al., 1990).

Summary of Knowledge Driven Model

The relationship between the integration of knowledge and practice was explained in studies involving the role of prior knowledge, the structure of knowledge stored in memory and its use in reasoning clinical decisions of the knowledge driven model of clinical reasoning and decision making. The model highlighted the importance of the recognition of meaningful information, clinical data cues and access to knowledge structures in memory.

The process of knowledge structure development begins with common pieces of information linking together to form networks of knowledge with continual development, through learning and exposure to patient problems in the clinical setting, and practice experiences. As a result knowledge undergoes a process of restructuring and reframing to form categories of discipline knowledge. With the increase in knowledge and practice experiences the categories become synthesised into meaningful units or patterns of discipline knowledge as a whole, rather than discrete pieces of knowledge. Knowledge is more sophisticated and the names given to this more sophisticated knowledge include as schemata and semantic networks. These involve knowledge encapsulation within developed illness scripts, and pattern recognition, which are clinical reasoning strategies of the expert, not the novice.

Chapter Summary

The nature of discipline knowledge and its role in health professionals' clinical decision making were reviewed in the literature from a number of disciplines within the health area. The literature established that clinical decision making in the demanding world of the health professional is complex and identified different paradigms employed in the decision making process.

Clinical reasoning and decision making studies were conceptually grounded in both the hypothetico-deductive model and the knowledge driven model. The hypothetico-deductive model was prominent in medical studies (Elstein, 1978; Offredy, 2002; Patel and Groen, 1986) and in nursing studies 1986a; Corcoran, 1986b; Fowler, 1997; Offredy, 2002; Tanner et al., 1987). All studies reviewed in hypothetico-deductive model highlighted a relationship between the quality of individuals' knowledge and the accuracy of their decisions. However the studies were limited in their ability to define the role of knowledge in the reasoning process.

The knowledge driven model identified the role of knowledge was the key component in reasoning clinical decisions by medical students and clinicians (Balla et al., 1990; Boshuizen and Schmidt, 1992; Grant and Marsden, 1987; Grant and Marsden, 1988; Patel and Groen, 1986; Patel et al., 1988; Schmidt and Boshuizen, 1993); and in nursing and midwifery (Cioffi, 2002; Cioffi and Markham, 1997). The accuracy of clinical decisions was directly related to the structure of an individual's discipline specific knowledge. Studies in the knowledge driven model provided some insight into how knowledge developed and how it was transformed with practice and experience with previous patient problems. Various studies explained how knowledge was structured in problem representations of semantic networks of schemas (Balla et al., 1990; Corcoran-Perry and Narayan 2000; Grant and Marsden, 1987; Grant and Marsden, 1988; Patel and Groen, 1986; Patel et al., 1988); pattern recognition and illness scripts of specific discipline knowledge (Boshuizen and Schmidt, 1992; Cioffi and Markham, 1997; Schmidt and Boshuizen, 1993). The similarities between clinicians' use of knowledge structured in these networks of reasoning processes involve the ability to recognise familiar patterns of problems and search within their prior knowledge for a match, judge its value and reason the outcome. In addition, the quality of individual knowledge structures differentiated the expert from the novice. The continual monitoring of these semantic knowledge networks as clinicians develop their expertise is the essence of good thinking (Alexander and Judy, 1988).

Studies reviewed in the midwifery literature did not adequately explain the development and structure of a discipline specific knowledge base or its role in decision making in midwifery practice and for that reason this topic requires further investigation. Findings from the studies using the hypothetico-deductive model identified the importance of discipline specific knowledge to reasoning; however they did not adequately explain how discipline specific knowledge develops through clinical practice experiences. Conversely the knowledge driven models did provide insight into the role of prior knowledge in students and experienced clinicians in reasoning decisions, the structure of knowledge and its use in reasoning, which could account for the differences between the student and the experienced midwife, for the current study.

The aim of this study is to investigate the knowledge growth and clinical decision making of the students (after their first and twentieth birth) and midwives in their practice, performing the task of a normal birth rather than in simulated decision making tasks. Students and midwives recalled what they did do in this situation rather than what thought they might do in an experimental situation.

The majority of the studies reviewed in this chapter used a series of experiments based on simulations in the form of case scenarios / studies, or with trained actors to simulate a patient. The use of these clinical studies methodologies limits the clinicians' reasoning to the information given. The findings from Patel and Groen's (1986) study, which examined experts' reasoning, are an example of where the methodology limited the results of the study itself. The authors noted that clinicians are trained to reason clinical situations. Further information can be gathered from a patient to confirm or reject their diagnostic hypotheses, which was not available in this experiment. These circumstances rather than the clinicians' reasoning strategy, accounted for the incorrect diagnosis. Few studies have considered the structural development of individuals' knowledge during the direct experience with patients in practice. Therefore collecting data from students and midwives' direct experiences with patients in practice will address some of the limitations identified by the studies reviewed in this chapter.

Student midwives' knowledge growth, the developmental processes of their discipline specific knowledge base, and the structure of experienced midwives discipline specific knowledge are examined in the next chapter.

While the midwifery literature described that specific midwifery knowledge is developed through practice, how midwifery knowledge is structured is not clearly defined. The knowledge, skills and attitudes of the midwife and the outcome of a competency based education program are known. How these attributes develop and form midwifery discipline specific knowledge is not clear and worthy of investigation. The developmental changes in students and midwives' knowledge as explained in the Benner's nursing proficiency practice levels (outlined in chapter one), and Cantwell's theory of cognition from the cognitive sciences literature will frame midwives' knowledge and practice development across different levels of expertise.

CHAPTER THREE: THE DEVELOPMENT OF A PRACTICE KNOWLEDGE BASE

In the previous chapter studies of midwifery, medical and nursing clinical decision making processes were reviewed. The hypothetico-deductive model studies were limited in their ability to define the role of discipline knowledge when reasoning and making clinical decisions. On the other hand the knowledge driven model studies shed some light on the role of knowledge used in decision making and in particular the manner in which individuals' knowledge is structured. The most important finding was the positive relationship between a well-structured discipline specific knowledge base and high quality decision making. Experts make higher quality decisions compared to novices.

The transition from student to midwife is examined in this chapter. The chapter defines the processes that shape the structure of student midwives' discipline specific knowledge base, and a description of experienced midwives' discipline specific knowledge. The process involves a 'theoretical' sequence of modality changes in thinking to explain student midwives' developing knowledge structure during learning. These changes in thinking were identified in Cantwell's theory of cognition (Cantwell, 2004). This theory will form the conceptual framework that underpins the 'theoretical' sequence of modality changes in thinking to explain the development of student midwives' discipline specific knowledge base. Evidence to support these developmental changes in thinking will be drawn from a number of sources: National Competency Standards for the Midwife (ANMC, 2006) (see appendix 4), Benner's nursing proficiency practice levels (outlined in Chapter one), midwifery knowledge and medical and nursing empirical studies. The key elements, of the developmental perspective, on the transition from student to midwife, begin with an outline of the theory of cognition in SOLO terms.

Theory of Cognition in SOLO Terms

The cognitive sciences literature describes changes in an individual's way of thinking as a sequence of within modality changes (Cantwell, 2004). This sequence of changes is based on the Structure of the Observed Learning Outcome (SOLO) taxonomy (Biggs and Collis, 1982; Biggs and Collis, 1989; Cantwell, 2004). The SOLO taxonomy outlines five qualitatively different levels of understanding namely the pre-structural, uni-structural, multi-structural, relational and extended abstract (see appendix five - Structure of the

Observed Learning Outcomes taxonomy characteristics). This development of modality changes in thinking is depicted in figure 3.1 below.

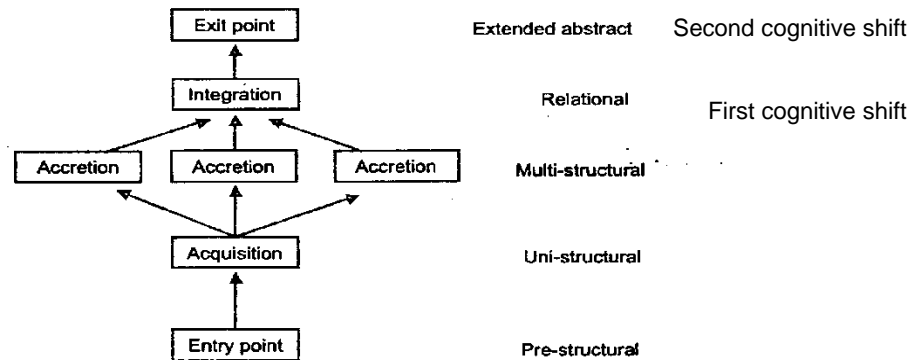


Figure 3.1: Linking individual's cognitive shift with SOLO levels

(Cantwell, 2004, p. 363)

The model represents the *acquisition*, *accretion* and *integration* of knowledge as a sequence of interconnected developmental changes that take place during the course of learning. The *entry point* signifies the beginning of learning a new discipline. The *acquisition* of a student's knowledge begins with elements of discipline knowledge, which are stored in memory in a '...relatively undifferentiated form' (Cantwell, 2004, p. 362) and are representative of the uni-structural level of understanding, or a reproduction of factual information.

Accretion of knowledge is defined as explicit processing of information into distinct 'packages' that are not linked. As students acquire more knowledge they begin to identify relationships between the various elements of information. These relationships enable them to categorise knowledge. The categories at this stage remain closed and tied to the concrete but are increasingly complex, representing the multi-structured level of understanding.

There is a shift in the modality of thinking from *accretion* to *integration*. The student recognises that the categories are not discrete as links between like categories of knowledge develop. Knowledge categories become less bound by the immediate context which then allows a greater degree of generality. The nature of thinking changes from one of factual learning to conceptual learning, therefore individuals are able to begin to

understand that the whole is more than the sum of the parts. In SOLO terms this represents the relational level of understanding: the first '*cognitive shift*' in thinking (Cantwell, 2004).

The *exit point* equates to the extended abstract level of understanding in SOLO terms. This level is characterised by a high level of abstract thinking. The individual is able to take in new and more abstract information within their existing knowledge structures. This mode of thinking illustrates the second '*cognitive shift*' (Cantwell, 2004).

The changes in thinking described above are not abrupt in nature but are transitional phases that advance at their own pace. Cantwell (2004) suggested that individual differences in students' development of thinking are influenced by their readiness for a higher level of learning, prior knowledge, educational background, and more general life experiences. Individual differences in prior knowledge has an impact on student's learning (Cust, 1995; Glaser, 1984). For example, at entry into a post graduate midwifery program the student may be a registered nurse or possibly a mature age student (Davis and Atkinson, 1991; McCrea et al., 1994). In the former, a midwifery student's prior knowledge would include human pathophysiology, clinical decision making abilities and skilled nursing experiences within the health care context. This prior knowledge and experience forms a base to build upon. On the other hand entry at the undergraduate level, the midwifery student begins with limited prior discipline specific knowledge and experience in health care contexts (Seibold, 2005).

The characteristics of Cantwell's knowledge acquisition model and the levels of understanding in SOLO terms are not simply descriptive by nature but do account for how the process of knowledge growth and practice develops at various levels of expertise. The next section outlines the evidence from other sources that can be used to support Cantwell's knowledge acquisition model and the levels of understanding in SOLO terms is discussed next. The sources are the *National Competency Standards for the Midwife*, *Benner's Model of Professional Nurse Development*, *Midwifery knowledge*, and *Medical and Nursing studies*.

National Competency Standards for the Midwife

The formal documents that detail all aspects of midwifery practice and the attributes of the midwife are contained in the *Scope of Midwifery Practice*, the *Decision Making Guidelines*, and the *National Competency Standards for the Midwife* (ANMC, 2006; ICM, 2005). The

various regulations and requirements within the documents guide professional midwifery practice and inform the learning outcomes of the midwifery program. The importance of higher-level thinking abilities in midwifery practice are accounted for in the *National Competency Standards for the Midwife* (fully detailed in appendix 4). The four domains cover the all aspects of the professional midwives' discipline specific knowledge and have similar characteristics to the last stage of Cantwell's model. However, the documents are descriptive in nature and the details of how midwives develop practice knowledge, its structure and use in practice, are not explicit.

Benner's Model of Professional Nurse Development

Benner's (1984) Model of Professional Nurse Development (outlined in Chapter one), describes the relationship between nursing knowledge and practice development. Benner's model is a widely accepted classification of nursing practice in the profession. Historically midwifery knowledge and practice had been identified as a speciality within the discipline of nursing, however it now stands alone as a formal discipline (outlined in Chapter one). Therefore, because its close association to midwifery Benner's nursing model will be used in the 'theoretical' sequence of modality changes that explain the developing structure of midwifery students' knowledge.

The model consists of five nursing proficiency practice levels: novice, advanced beginner, competent, proficient and expert, which are used to measure an individual's practice competence (Benner, 1984). According to Benner's model nurses begin as a *novice* and with increasing knowledge and experience gained through practice move through five proficiency levels at their own pace. The second level describes the *advanced beginner* as who is able to recognise data cues but often unable to use these cues to make a decision, however with experience and a developing knowledge base moves to the *competent* level of practice. At the *proficient* level a nurse will function independently and anticipate potential problems as a result of their experiential knowledge. Finally the *expert* level nurse displays independent skills, higher order thinking skills and is advanced in their practice discipline. Some characteristics of the *proficient* and *expert* levels overlap. Benner's nursing proficiency practice levels represent expertise in nursing practice and are descriptive in nature.

Midwifery Knowledge

The midwifery literature suggested that a sound discipline and clinical knowledge base develops from past experiences working with women, in the intuitive women-centred care model of practice (Danerek and Dykes, 2001; Freeman, 2003; James et al., 2003; Price and Price, 1993; Siddiqui, 2005; Weaver et al., 2005). Midwives' knowledge develops through years of experience, and is underpinned by a deep understanding of birthing. This knowledge structured as problem representations has been called their 'bag of tricks' by James and colleagues (2003). Danerek and Dykes (2001) similarly described midwifery knowledge as an integrated network of prior theoretical knowledge and clinical practice experience. Cioffi and Markham (1997) described the knowledge used by midwives to reason clinical decisions are structured in a framework of heuristics.

The demands of professional midwifery practice require midwives to possess higher-order thinking abilities and advanced practice skills, and to function effectively and efficiently, by being able to access a comprehensive discipline specific knowledge base. The ability to translate this comprehensive knowledge into practice is what defines a competent midwife. Although no one classification of midwifery knowledge was found in the literature, midwifery knowledge is embedded within the discipline: and what constitutes midwifery knowledge is the practice of its discipline (Kelly, 1997).

The types of midwifery discipline specific knowledge have been described as declarative, procedural and conditional knowledge. Declarative knowledge contains the pathophysiology of birth, maternal, foetal and newborn anatomy and circulation (the facts, and concepts related to the midwifery knowledge) essential to understanding (what) and practice skills and techniques knowing (how) to perform the task. This is procedural knowledge. Conditional knowledge structures develop through continual growth of students' declarative and procedural knowledge. Knowing the 'when' and 'why' of their declarative and procedural knowledge is used to make judgments and reason decisions, and forms an individual's practice discipline. This discipline specific knowledge also contains information about the birth setting which is governed by regulatory guidelines on the use of equipment and collaboration with team members.

Medical and Nursing Studies

The development of knowledge and the role of knowledge in practice are important to midwives. However, there appears to be a gap in the midwifery literature about our understanding of how a midwifery knowledge base develops. On the other hand, a large body of medical and nursing literature contains numerous studies that have examined the structure of knowledge and its role in decision making in various levels of expertise (Boshuizen and Schmidt, 1992; Boshuizen et al., 1995; Grant and Marsden, 1988; Larkin et al., 1980; Patel et al., 1988).

These medical studies have described the sequence of developmental changes in knowledge. The sequence begins with each piece of like information connecting to form networks, then through a process of restructuring and reframing the networks cluster together and form categories of discipline knowledge. With increasing knowledge and experience the categories become integrated with prior knowledge into meaningful units or patterns of discipline knowledge as a whole, rather than discrete pieces of disease knowledge. The characteristics of these studies have highlighted knowledge growth and practice development in various levels of expertise and have similar features to Cantwell's knowledge acquisition model and levels of understanding in SOLO terms. The nursing studies also characterise the expert level. Both medical and nursing studies showed how the experienced clinicians had transformed their knowledge into structures of clinical problems used to reason decisions by encapsulating knowledge concepts to form illness scripts (Boshuizen and Schmidt, 1992); pattern recognition (Azzarello, 2003); schema theory (Balla et al., 1990; Glaser, 1984; Patel and Groen, 1986; Grant and Marsden, 1988; Offredy, 2002), and heuristics (Fowler, 1997; Cioffi and Markham, 1997).

In Table 3.1 Cantwell's knowledge acquisition model and its developmental changes described in SOLO terms are aligned with the *National Competency Standards for the Midwife*, *Benner's Model of Professional Nurse Development*, *midwifery knowledge categories*; and *medical and nursing studies* (ANMC, 2006; Benner, 1984; Biggs and Collis, 1989; Cantwell, 2004). The content of these five columns may inform and account for the 'theoretical' sequence of modality changes in thinking, and explain the development of students and midwives' discipline specific knowledge base.

In the first column, the *National Competency Standards for the Midwife* are represented in a continuous vertical dimension because they apply across all levels of students'

developing knowledge. The four midwifery practice domains, with 14 competency statements, form the regulatory framework of professional midwifery practice.

In the second column Benner's nursing proficiency practice levels are described beginning with *novice* through to *expert*. These practice levels have similar characteristics to the levels described in Cantwell's knowledge acquisition model. Benner's *novice* level parallels the *knowledge acquisition* phase at the *uni-structural* level of understanding; the *advanced beginner* parallels *knowledge accretion* at the *multi-structured* level of understanding; the *competent* practice level parallels *knowledge integration* at the *relational* level of understanding (the first cognitive shift in thinking); and the *proficient* and *expert* level of practice parallels *exit point and the extended abstract* level of understanding (the second cognitive shift in thinking).

The fourth column illustrates midwifery in declarative, procedural and conditional knowledge. Each knowledge type aligns with the levels of Benner's proficiency practice and Cantwell's knowledge acquisition model. Declarative knowledge begins developing at the *novice* level and *knowledge acquisition*; procedural knowledge is developing along with declarative knowledge in the *advanced beginner* and *knowledge accretion* levels as well as *competent* practice and *knowledge integration* levels; and conditional knowledge in the *proficient* and *expert* level of practice and the *extended abstract* phases.

The fifth column summarises evidence of developmental changes in thinking from medical and nursing studies. The studies are grouped and show a relationship to Benner's proficiency practice levels, Cantwell's knowledge acquisition model and the declarative, procedural and conditional midwifery knowledge.

The dotted line of the vertical dimensions of column two, three, four and five signifies that the changes to individuals of modality of thinking are not abrupt but are developmental in nature.

Table 3.1 may be used to illustrate how the various sources can be combined to describe the development of discipline specific knowledge. For example, a comparison between a *novice* and *proficient* level of knowledge and practice development can be made. The knowledge and practice of a novice would have limited links to the midwifery competency standards framework. The second column, Benner's practice model, describes a novice as one who has no prior practice experiences. *Novices* are reliant on practice rules and

require supervision and assistance with practice. The novice level equates to the *acquisition* of knowledge at the *uni structural* level of understanding (Cantwell, 2004). Novices have difficulty reasoning decisions because of their limited experience and knowledge. The content of their midwifery knowledge is factual and scientific (declarative knowledge) and is not cohesively structured (Boshuizen and Schmidt, 1992; Patel and Groen, 1986).

At the *proficient* level the midwife's knowledge and practice is exhibited in all four of the midwifery competency domains. The nursing student will have made a quantum leap from the previous (*competent*) level of practice, and be able to recognise clinical situations as a whole, practice within guided principles and function independently (Benner, 1984). At the *proficient* level the student is adept at anticipating potential problems from unusual patterns of clinical data by evaluating the alternatives from their well-structured knowledge of practice. This higher level of thinking equates to an *extended abstract* level of understanding where they are able to generalise their new knowledge within existing knowledge structures. The mode of thinking illustrates the second '*cognitive shift*' (Cantwell, 2004). The content and structure of their midwifery knowledge will be organised into categories of declarative, procedural and conditional knowledge. They know the 'when' and 'why' to apply conditional knowledge to make judgments and reason decisions. This highly structured knowledge with its abstract principles demonstrates higher-order thinking abilities (Boshuizen and Schmidt, 1992; Cholowski, 1998; Hassebrock 1993; Schmidt, Norman and Boshuizen 1990).

Table 3.1: Midwifery competency standards, proficiency practice levels, developmental cognition, defining midwifery knowledge and evidence from medical and nursing literature

Midwifery competency standards	Proficiency <i>practice</i> levels – characteristics	Developmental <i>cognition</i> in SOLO taxonomy equivalence – characteristics	Defining midwifery knowledge	Evidence from medical and nursing literature
<p>Midwifery student learning and performance criteria articulated in 4 <i>midwifery practice domains</i> and represented by 14 <i>competency standards</i></p> <p>The <i>legal and professional practice domain</i> represents:</p> <p>Competency 1: Functions in accordance with legislation and common law affecting midwifery practice; and</p> <p>Competency 2: Accepts accountability and responsibility for own actions within midwifery practice.</p>	<p>Novice No experience in the situation Dependent upon rules to guide their actions Unable to transfer knowledge Detached observer</p> <p>Requires supervision and assistance with practice</p>	<p>Entry point = pre-structural level Engagement in domain specific discipline, and beginning of new knowledge concepts.</p> <p>Acquisition = Uni-structural level Mainly focuses on the domain knowledge, unrelated to concepts and often irrelevant links to disease therefore unable to reason effectively. A heavy reliance on retelling of basic knowledge information with minimal transformation.</p>	<p>* scientific knowing (declarative) Hunter (2007)</p> <p>* scientific knowledge (declarative) Kelly (1997)</p> <p>* discipline knowledge (declarative) Greener (1988)</p> <p>* scientific knowledge (declarative) Fleming (1998)</p> <p>* empirical knowledge (declarative) Siddiqui (1994, 2005)</p> <p>* knowledge (declarative) Cioffi (1998)</p>	<p>a loosely beginning structured knowledge base, knowledge gaps foremost in weaker knowledge association, unable to correlate normal to abnormal disease processes (Boshuizen and Schmidt 1992; Patel and Groen, 1986; Patel, Groen and Scott, 1988; Schmidt and Boshuizen, 1993)</p> <p>Develop a knowledge structure with increasing experience Grant and Marsden, (1988)</p>

Midwifery competency standards	Proficiency <i>practice</i> levels – characteristics	Developmental <i>cognition</i> including SOLO taxonomy equivalence	Defining midwifery knowledge	Evidence from health professional literature
<p>The <i>midwifery knowledge and practice domain</i> represents:</p> <p>Competency 3: Communicates information to facilitate decision-making by the woman.</p> <p>Competency 4: Promotes safe and effective midwifery care.</p> <p>Competency 5: Assesses, plans, provides and evaluates safe and effective midwifery care</p> <p>Competency 6: Assesses, plans, provides and evaluates safe and effective midwifery care for the woman and / or baby with complex needs.</p> <p>The <i>midwifery as primary health care domain</i> represents:</p> <p>Competency 7: Advocates to protect the rights of women, families and communities in relation to maternity care.</p> <p>Competency 8: Develops effective strategies to implement and support collaborative midwifery practice,</p>	<p>Advanced beginner Task-oriented, can identify aspects, organises and prioritises tasks Still uses procedural lists Some limited exposure to real situations Remains focussed on rules Marginal satisfactory performance Recognises concrete manifestations of clinical signs and symptoms Unable to differentiate</p> <p>Less likely to grasp variation and patterns within particular situations</p>	<p>Accretion = multi-structural level Develops more and more relevant or correct features without the ability to integrate them. Evidence of understanding, or ability to apply knowledge to several aspects of the task, unintegrated; and characterised by the assimilation of knowledge.</p>	<p>* knowledge and experiences (procedural) Cioffi (1998)</p> <p>* knowledge and experience (procedural) Kelly (1997)</p> <p>* clinically competent (procedural) Hunter (2007)</p> <p>* technical expertise (procedural) Siddiqui (1994, 2005)</p>	<p>Knowledge encapsulation (Boshuizen and Schmidt 1992; Schmidt and Boshuizen, 1993)</p>
	<p>Competent Clinical postgraduate experience of 2-3 years Actions based upon conscious, abstract, analytical reflection of a problem Able to prioritise attributes and aspects, often lacks speed and flexibility Mastery of skills in the clinical setting Functions and manages in the clinical nursing context Increased responsibility, can explain and interpret situations</p> <p>Can work independently, planning based on goals</p>	<p>Integration = relational level <i>First cognitive shift</i> Now able to associate and integrate the parts of knowledge with each other so that the whole has a coherent structure and meaning. Able to show selective judgment in what knowledge is important and what is less important in reasoning clinical practice.</p>		<p>Pattern recognition (Azzarello (2003)</p> <p>schema theory semantic networks (Balla et al.,1990; Bordage, 1994; Bordage and Lemieux, 1991; Fowler, 1997; Glaser, 1984; Grant and Marsden,1987, 1988; Offredy, 2002; Patel and Groen, 1986)</p> <p>heuristics (Fowler, 1997; Pyles and Stern, 1983; Cioffi and Markham, 1997)</p> <p>Illness scripts (Boshuizen & Schmidt 1992; Schmidt and Boshuizen, 1993).</p>

<p>Competency 9: Actively supports midwifery as a public health strategy, and</p> <p>Competency 10: Ensures midwifery practice is culturally safe.</p> <p><i>The reflective and ethical practice domain</i> represents</p> <p>Competency 11: Bases midwifery practice on ethical decision making,</p> <p>Competency 12: Identifies personal beliefs and develops these in ways that enhance midwifery practice,</p> <p>Competency 13: Acts to enhance the professional development of self and others and</p> <p>Competency 14: Uses research to inform midwifery practice.</p>	<p>Proficient A quantum leap from competency, perceives situations as a whole performance guided by principles; no longer rules Can recognise when normal is absent Considers fewer options when trying to solve problems</p> <p>Functions independently, sees changing relevance, can anticipate potential problems, has experiential knowledge</p> <p>Expert Intuitive behaviour/practice Minimum of 5 years clinical postgraduate experience Able to quickly assess critical areas in a problem situation Considers multiple solutions, intuitively knows which solution will work Holds deep grasp of clinical situations based on years of experience In new situations, uses highly skilled analytical abilities</p> <p>Manages rapidly changing situations, able to attend to many other aspects of care, simultaneously manages multiple complex therapies</p>	<p>Exit point = extended abstract <i>Second cognitive shift</i> Generalises structures to synthesise new and more abstract features, representing a higher mode of operation. Characterised by a high level of abstract thinking, able to generalise or re-conceptualise new contexts, to reason with greater accuracy and less effort by being highly abstract</p>	<p>*intuitive and embodied knowledge; ways of knowing; professional & knowledgeable (conditional) Hunter (2007)</p> <p>* intuitive tacit personal knowledge (conditional) Siddiqui (1994, 2005)</p> <p>* heuristics (conditional) (Cioffi 1997)</p> <p>* blended context knowledge (conditional) Greener (1988)</p> <p>* ways of knowing & knowing woman (conditional) Fleming (1998)</p> <p>* knowledge based on experience & knowing woman (conditional) Kelly (1997).</p>	<p>Highly structured knowledge base</p> <p>Abstract principles</p> <p>Higher-order thinking abilities</p> <p>(Benner, 1984; Bordage and Lemieux, 1991; Boshuizen and Schmidt, 1992; Cholowski, 1998; Hassebrock 1993; Schmidt, Norman and Boshuizen 1990; Patel, Groen and Arocha, 1990).</p>
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(ANMC, 2006; Benner, 1984; Benner and Wrubel, 1989; Benner et al., 1992; Biggs and Collis, 1989; Cantwell, 2004)

Development of a Discipline Specific Knowledge Base

This section of the chapter explores in detail how Cantwell's theory of cognition, the midwifery competency standards, the characteristics of Benner's model of proficiency practice levels, midwifery knowledge, and medical and nursing literature together may inform and account for the development of midwives' discipline specific knowledge.

The discussion begins with the acquisition of knowledge at the uni-structural level of understanding in the model and follows the developmental path to the exit point at the extended abstract level of understanding (Biggs and Collis, 1989; Cantwell, 2004).

The Acquisition of Knowledge and Uni-Structural Levels of Understanding

Cantwell's model (see figure 3.1) describes the developmental changes that take place during the course of learning in a new discipline. Learning a new discipline begins with *acquisition* of knowledge (Cantwell, 2004). When a student begins their learning in any new discipline they start with acquiring facts or declarative knowledge. In the *acquisition* phase these facts are stored in memory as discrete pieces of information because the links between these pieces of information are very loose. As a result the level of understanding at this stage is *uni-structural* (Biggs and Collis, 1989). The student here is able to reproduce factual information when reasoning which is typical of beginners in a number of disciplines.

The relationship between the quality of knowledge and decision making is linked. Studies that examined the clinical decision making of medical students and nurses found that their knowledge influenced the outcome of their decision making (Benner, 1984; Boshuizen and Schmidt, 1992; Boshuizen et al., 1995; Tanner et al., 1987; Westfall et al., 1986). In the initial stage of knowledge development medical students use each piece of like information to make connections that form a network; and through a process of restructuring and reframing, the network of information cluster together to form categories of common knowledge (Boshuizen and Schmidt, 1992; Boshuizen et al., 1995). On the other hand studies of student nurses' knowledge development was not as specific. However Tanner et al., (1987) and Westfall et al., (1986) identified that the quantity and quality of student nurses' prior knowledge was limited during the beginning stages of learning and practice. They also described students' basic information as fragmented structures of declarative knowledge. This fragmented knowledge affected their ability to access the meaning and significance of

patients' data cues, and therefore their ability to generate a hypothesis and reason an outcome. Benner (1984) also highlighted this inability when describing the characteristics of a *novice* proficiency practice level.

During the *acquisition* of knowledge phase students' practice (procedural) knowledge is also forming. Procedural knowledge is associated with individuals' skills, manual dexterity, and the psycho-motor skills and techniques fundamental to developing practice (Bjark, 1997; Jerlock et al., 2003; Kelly, 1997). The beginners' declarative knowledge (the facts and concepts related to the new discipline knowledge) is essential to understanding the procedural knowledge of how to perform a task. Decision making is limited because their practice is in the early phase of development. Both declarative and procedural knowledge are developing during this *acquisition* of knowledge phase.

The studies that examined the relationship between medical students' knowledge and their decision making outcomes found that it varied according to level of expertise (beginning, intermediate or final year students) (Grant and Marsden, 1988; Patel et al., 1988). The beginning students' loosely structured knowledge was not strongly linked to their clinical practice (procedural knowledge) and reasoning was often inaccurate. In difficult or unfamiliar situations they would simply revert to using declarative knowledge to reason and often invented links to causal rules based on personal experiences (Patel et al., 1988). This restricted their ability to identify normal and abnormal disease processes, but with increasing expertise the picture changed and accurate diagnoses were associated with the use of more relevant declarative and procedural knowledge. The graduating students used more accurate causal rules and clinically based knowledge to reason than the novices (a different level of understanding discussed later in the chapter).

Novices are not independent practitioners because of their inadequate knowledge base. In the nursing studies novice students' practice was limited to simple tasks, which required assistance and supervision (Tanner et al., 1987; Westfall et al., 1986). Benner's proficiency practice level characterises a *novice* in a similar manner (Benner, 1984). Novices with their developing knowledge and practice are unable to reason effective outcomes. Novices were described as a 'detached observers' in clinical situations because of their limited practice knowledge, which relied on formal practice principles to guide their practice.

The studies of novice medical and nursing students are used to describe a novice midwife's practice because there appears to be a gap in the midwifery literature to explain the development of midwifery knowledge. The results from the studies outlined above are used to inform the description of knowledge development in a beginning midwife. A sound midwifery knowledge base is a combination of an integrated theoretical knowledge and clinical practice experience and has been referred to in the literature as the art and science of midwifery knowledge (Cioffi, 1998; Danerek and Dykes, 2001; Hunter, 2007; Siddiqui, 1994 and 2005; Sullivan, 2005). With this knowledge midwives have the ability to quickly access and identify the whole problem to reach a positive outcome and this effective decision making is fundamental to professional midwifery practice.

Beginning *midwifery knowledge* and practice skills develop throughout the course of students' learning and while performing clinical tasks. Students begin their practice in an unfamiliar clinical setting with little understanding of the birth task other than that gained from formal learning and classroom practice. The students' knowledge of the birth chronology is limited to a description of the stages of labour: stage one is the beginning of labour to full dilation of woman's cervix; stage two is delivery of the baby; and stage three is expulsion of the placenta. Therefore at this level they need to be regularly supervised by an experienced midwife (Siddiqui, 2005).

The quality of a beginning student midwives' knowledge structure is limited to the *uni-structural* level of understanding, their prior pathophysiology of birth, maternal, foetal and newborn anatomy and circulation knowledge is not integrated, because of limited links between knowledge and practice. This description of student *midwifery knowledge* is consistent with Benner's description of a *novice* and the beginning medical and nursing students' practice.

In sum, the *acquisition* of knowledge at the *uni structural* level of understanding, outlined in Cantwell's account begins by learning and forming declarative knowledge structures. The novice medical and nursing students were found to be limited in their practice due to weaker knowledge associations (Patel and Groen, 1986) and a non-integrated symptom by symptom approach, which influenced the quality of their reasoning (Ericsson and Charness, 1994; Patel et al., 1994). Benner's model also described the *novice* in a similar manner. Student midwives' knowledge at this level of understanding is characterised by unrelated pieces of information stored in memory as fragmented structures of declarative

knowledge: knowledge of anatomy and pathophysiology of the woman and her foetus, the chronology of birth, and midwifery care information.

The Accretion of Knowledge and Multi-Structural Level of Understanding

The *accretion* of knowledge is the next developmental phase for learners (Cantwell, 2004). With increasing use of knowledge and its direct application in practice, learners begin to identify relationships between the various elements of information. Networks of common information form distinct categories which develop depth and breadth accompanied by changes in thinking from remembering information to knowing information. This development represents a shift from factual learning to increasingly more conceptual learning. The categories at this stage become progressively more complex. As a result the level of understanding at this stage is *multi-structural* (Biggs and Collis, 1989). The student is able to recognise clinical data cues when reasoning though often unable to differentiate between their significance (Cantwell, 2004).

Students' knowledge growth and practice experience contributes to the development of their knowledge structures. Studies examining clinical decision making in medical students and nurses described how knowledge networks are structured with increased use of knowledge and practice experiences (Benner, 1984; Boshuizen and Schmidt, 1992; Boshuizen et al., 1995; Cust, 1995; Tanner, 1998; Tanner et al., 1987; Westfall et al., 1986). During the accretion stage of knowledge development medical students' basic declarative knowledge forms elaborate networks of detailed disease concepts by repeated use in reasoning diagnoses and treating patients (Boshuizen and Schmidt, 1992; Grant and Marsden, 1988; Patel et al., 1988; Schmidt and Boshuizen, 1993). The relationships between common pieces of declarative knowledge form direct lines within networks of common knowledge concepts.

Cohesion between disease concepts form packages of networked knowledge and practice information; and knowledge becomes encapsulated (Boshuizen and Schmidt, 1992; Schmidt and Boshuizen, 1993). These encapsulated concepts are more comprehensive clinical concepts or semi clinical diagnostic labels of semantic networks that summarises a whole pathophysiological process (see chapter 2) (Boshuizen et al., 1995). In a similar explanation medical students' knowledge develops compartments and categories in networks of disease structures, which go on to form interconnecting networks of commonalities between diseases (Patel et al., 1988).

Networks of knowledge at the *accretion* of knowledge stage remain discrete, but as expertise develops the networks become increasingly complex and use in reasoning is less likely to be a conscious process. The more frequently knowledge is used the more sophisticated and efficient knowledge structures become (Alexander, 1996). The development of knowledge structures and clinical reasoning of the medical students are not mutually exclusive but are in various stages of change throughout Cantwell's account of knowledge *accretion*.

Nursing studies of knowledge and reasoning processes were not as comprehensive as the medical studies. Student nurses (with two years minimum practice experience) develop knowledge networks that enabled them to reason accurate decisions. They asked significantly more clarifying questions (than the novice) to form a hypothesis and reason an outcome. At this level of development students' use of knowledge in reasoning were found to be similar to medical students (Tanner et al., 1987; Westfall et al., 1986).

As students' practice changes so does their developing knowledge. They are able to manage several aspects of a task at the one time and have become accustomed to the practice setting (Cust, 1995; Tanner, 1998). At the *advanced beginner* proficiency practice level in Benner's model skills are task orientated (Benner, 1984). Students remain focused on practice rules and procedural lists but are able to recognise concrete manifestations of clinical signs and symptoms. As a consequence, students are less likely to grasp the variations and patterns within particular situations (normal versus abnormal disease patterns and processes) because of their limited exposure to real practice situations. At the *advanced beginner* proficiency level declarative knowledge and procedural knowledge skills are continually developing (Benner, 1984). The student midwives' declarative and procedural knowledge networks develop in a similar manner to Cantwell's knowledge *accretion* and Benner's *advanced beginner*.

There are four networks of midwifery knowledge essential in performing a normal birth task. The content of the first network is the baby's anatomy, pathophysiology and developmental growth from foetus to newborn (declarative knowledge); the second network contains the anatomy and pathophysiology of women (declarative knowledge); the third network is an understanding the skills and techniques working in the birth setting (declarative and procedural knowledge); and a final network contains individuals' personal and professional conditional knowledge. These are complex knowledge networks, for

example the knowledge required to deliver a baby's head: the learners' first network will involve knowledge the baby's position in the uterus, recognising the signs of descent and the appearance of baby's head through the final part of the birth canal. The second network requires observing the physical condition of the woman in relation to the baby's head; and finally assessment of the woman's effort and coping ability during the birth and descent of the baby's head. The third network contains the knowledge of the birth setting's regulatory guidelines; the skill of performing the task, the use of equipment and safety of the woman, her carers and the birth team. The fourth network contains learners' personal and professional knowledge. For example, how to plan (the delivery of the head), monitor (their knowledge and skill) and evaluate the data cues that require attention during the delivery of the baby's head, which is a skilled component of a normal birth. This complex part of the birthing process involves comprehensive declarative and procedural knowledge, which throughout the knowledge *accretion* stage are transforming.

Practice experiences and developing depth and breadth to a learner's declarative and procedural knowledge structures does not necessarily equate to the transformation of knowledge (Benner, 1984; Ferry and Ross-Gordon, 1998; Peden-McAlpine, 2000; Price and Price, 1993; Sullivan, 2005). Knowledge transformation may not occur because novice learners '*...rarely reflect on their own performance and seldom evaluate or adjust their cognitive functioning to meet changing task demands or to correct unsuccessful performances*' (Ertmer and Newby, 1996 p. 6). To overcome this limitation, the skill of self-reflection is essential and a critical link in the developmental process (Cahill and Fonteyn, 2000; Tanner, 2006; Titchen and Higgs, 2000), as apposed to regulation by others (Gourgey, 1998; Schraw, 1998; Schraw and Moshman, 1995). Atkins and Murphy state that reflection '*...must involve the self and must lead to a changed perspective. It is these crucial aspects which distinguish reflection from analysis*' (1993, p. 1191). A perspective transformation can be the result of a single critical incident, or a sudden insight into where pieces of previous information came together as a whole structure (Nakielski, 2005).

Changes in thinking cannot be taught (Benner and Tanner, 1987). The role of a clinical mentor, clinical supervisor or critical companion is important when guiding this developmental process (Azzarello, 2003; Duerden, 2005; Forneris and Peden-McAlpine, 2006; Hicks, Merritt and Elstein, 2003; Licqurish and Seibol, 2008; Titchen and Higgs, 2000). Clinical mentors facilitate student midwives' reflection skills by using constructive questioning to guide their thinking (Nakielski, 2005). By exposing the student to an expert's experience, it converts their thinking processes and emphasizes the gradual

transfer of relevant self-regulatory or metacognitive strategies from the mentor to student (Volet, 1991). This guided self-reflection leads to a change in thinking from previously held assumptions or perspective transformation, and assists learners' critical thinking skills in the construction of a more sophisticated knowledge base.

In sum, during the *accretion* phase of knowledge and practice learners' develop a depth and breadth to their knowledge structures. Throughout the course of learning, increased knowledge and experience are transformed by processing connecting common pieces of information into distinct networks of knowledge categories. The students' categorised declarative and procedural knowledge structures are developing. The midwifery student's reasoning process focuses more on their declarative knowledge (stages of labour in the chronology of birth) as they begin to process changes in thinking from remembering information to knowing information. These changes in thinking are assisted by a clinical mentor.

There are individual differences in students' rate of development in thinking. Some students' knowledge is in the process of development during this phase and some may display characteristics of knowledge *integration*. This next level of understanding represents a qualitative cognitive shift in thinking. The integration of knowledge in the relational level of understanding is discussed next.

The Integration of Knowledge and Relational Level of Understanding

The *integration* of students' knowledge development through this phase represents a qualitative shift from concrete thinking to conceptual thinking, which Cantwell identified as the *first cognitive shift* (Cantwell, 2004). The links between networks of common information develop resulting in integrated networks of discipline specific knowledge structures. The structures have formed schemas or patterns for use in reasoning clinical problems.

The integrated knowledge networks or schemas are the result of a shift from a quantitative accumulation of declarative knowledge into a deeper understanding of a topic (Biggs, 1999). This deeper understanding contains declarative knowledge, a structured collection of facts and procedural knowledge, and clinical practice skills and techniques. Knowledge structures form links and relationships between facts, the task itself and patterns of specific clinical practice outcomes. In practice the students plan, monitor and evaluate care, make judgments to reason decisions by knowing 'when' and 'why' to apply their declarative and procedural knowledge, to develop conditional knowledge. Conditional knowledge is the nature of an

individual's discipline specific knowledge (Alexander and Judy, 1988; Cust, 1995; de Jong and Ferguson-Hessler, 1996; Schraw and Moshman, 1995). As a result the level of understanding at this stage is *relational* (Biggs and Collis, 1989). Knowledge has transformed and students become confident and independent in practice, which parallels Benner's proficiency practice levels characterised as *competent* (Benner, 1984).

The differences in knowledge structures and decision making between novices and various levels of expertise are illustrated in table 3.2. Studies of medical students captured these differences in three levels of expertise, the novice, the intermediate and the experienced (Boshuizen and Schmidt, 1992; Schmidt and Boshuizen, 1993). Knowledge structures form and are restructured in two stages known as encapsulation and illness scripts. At the intermediate level the students have more networked and encapsulated knowledge to reason with and the demand on their cognitive activity has decreased. On the other hand the more experienced have structured their knowledge into illness scripts with many enabling conditions and consequences of specific diseases. The automatic process of reasoning using illness scripts required less cognitive load as they moved into sophisticated forms of pattern recognition using this prior knowledge (Boshuizen and Schmidt, 1993; Schmidt et al., 1990). The different levels of expertise of knowledge integration and its relationship to clinical reasoning are presented in table 3.2.

Table 3.2: Knowledge acquisition and clinical reasoning in different levels of expertise.

Expertise level	Knowledge representation	Knowledge acquisition and (re) structuring	Clinical reasoning	Control required in clinical reasoning	Demand on cognitive activity
Novice	Networks	Knowledge accretion and validation	Long chains of detailed reasoning steps through pre-encapsulated networks	Active monitoring of each reasoning step	High
Intermediate	Networks	Encapsulation	Reasoning through encapsulated networks	Active monitoring of each reasoning step	Medium
Experienced	Illness scripts	Illness script formation (instantiated scripts)	Illness script activation and instantiation	Monitoring of the level of script instantiation	Low

(Boshuizen and Schmidt, 2000 p. 18).

Table 3.2 describes the differences in developmental processes of knowledge and clinical reasoning between three levels of medical expertise (the novice, intermediate and experienced) and demonstrates that more experienced medical students have integrated

their knowledge. Development of integrated knowledge structures were formed, structured and restructured with increasing use in practice and are similar to Cantwell's account of knowledge *integration* at the relational level of understanding.

In nursing studies the more experienced had better access to their prior knowledge than the less experienced student nurses (Westfall et al., 1986). With this prior knowledge they were able to make meaning of patients' data cues and evaluate their significance to generate a hypothesis and reason complex cases accurately (Tanner et al., 1987; Westfall et al., 1986). The development of their prior knowledge was not detailed but students' use of knowledge in reasoning at this level was similar to medical students.

The notion of using prior knowledge in the recognition of data cues to reason is similar in character to pattern recognition (Azzarello, 2003); schema theory (Bucknall, 2000; Fowler, 1997; Glaser, 1984; Grant and Marsden, 1987; Grant and Marsden, 1988); heuristic strategies (Cioffi and Markham, 1997; Pyles and Stern, 1983); semantic networks (Bordage, 1994; Bordage and Lemieux, 1991; Patel et al., 1988); and illness scripts (Boshuizen and Schmidt, 1992; Custers et al., 1998; Schmidt and Boshuizen, 1993) referred to in the medical and nursing studies. The terms although different in name have similar characteristics that explain the structure of an individual's discipline specific knowledge (de Jong and Ferguson-Hessler, 1986; Feltovich and Barrows, 1984; Grant and Marsden, 1988).

Benner's *competent* proficiency practice level parallels Cantwell's knowledge *integration* at the *relational* level of understanding (Benner, 1984; Cantwell, 2004). At this level of knowledge development students are skilled, in their clinical setting, and responsible clinicians. They reason through an analytical reflection of a problem, can interpret situations and explain their actions. Practice is independent and planning is based on outcome goals at this *competent* level of practice.

The student midwives' networks of knowledge and practices develop in a similar manner to Cantwell's knowledge *integration* and Benner's *competent* nurse. By their consistent application in practice the integration of their declarative (babies and women's anatomy and pathophysiology); procedural (skills and techniques) and conditional (plan, monitor and evaluate care) knowledge of a normal birth task changes from discreet networks of knowledge to understanding birthing as a whole.

To illustrate the content of students' declarative, procedural and conditional knowledge base the activity of monitoring the baby's heart rate during labour will be used. Firstly, require knowledge of the normal range of changes that occur during the first and second stages labour, with and without contractions, the descent of the head through the birth canal and the possible causes for unusual deviations from the norm. They then need to select the correct equipment and explain the procedure to the woman. Next they need to palpate the woman's abdomen for the position of the baby to pinpoint the proximity of its prominent shoulder (the most appropriate position to hear the baby's heart beat) place the monitor in position, listen to the heartbeat and interpret the findings. The consistent monitoring of baby's heartbeats throughout labour allows students to evaluate the progress of labour (by tracking the decent of the shoulder) and assess the baby's condition to alert them to possible concerns that might require action.

By a process of selective judgment when planning, monitoring and evaluating the normal birth progress, students now have the ability to distinguish between what data cues are important and relevant, and what are less important to reason their decisions. Decision making draws upon their prior knowledge and experiences rather than constructing each decision from scratch. With this knowledge most student midwives are independent in their practice because of repeated experiences of similar patient situations and will continue to restructure and reform patterns of prior knowledge (Ashcraft, 2001; Danerek and Dykes, 2001; James et al., 2003; Orme and Maggs, 1993; Simon, 1980). These patterns of midwifery discipline specific knowledge guide individuals' decision making (Siddiqui, 2005).

The integrated discipline specific knowledge structures are important for student midwives to attain the level described in the *National Competency Standards for the Midwife: a '...standard that is judged to be appropriate for the level of assessment'* (ANMC, 2006 p.8). For example, in the Midwifery Knowledge and Practice domain (competency unit 5) describes the knowledge, skill and attitude of midwives' practice to enable them to assess, plan, provide and evaluate safe care for the woman and her baby (ANMC, 2006). The on-going integration and structure of midwives' discipline specific knowledge also takes into account the Legal and Professional Practice, Midwifery as Primary Health Care and Reflective and Ethical Practice domains.

In sum, the *integration* of student's knowledge and practice at the *relational* level of understanding represents a qualitative cognitive shift in thinking. Changes in thinking have

formed more sophisticated schemas or patterns used to reason clinical problems. With this integrated knowledge students are confident and independent in their practice which Benner's refers to as the *competent* proficiency practice level.

The medical and nursing studies also acknowledge that the integration of students' knowledge and practice develops into patterns of prior knowledge for use in decision making. These patterns are similar in character to pattern recognition (Azzarello, 2003); schema theory (Bucknall, 2000; Fowler, 1997; Glaser, 1984; Grant and Marsden, 1987; Grant and Marsden, 1988); heuristic strategies (Cioffi and Markham, 1997; Pyles and Stern, 1983); and semantic networks (Bordage, 1994; Bordage and Lemieux, 1991 Patel et al., 1988). Of particular importance, is how medical students' encapsulated knowledge concepts into illness scripts, which contain their experiences of enabling conditions and consequences of specific diseases outcomes (Boshuizen and Schmidt, 1992; Schmidt and Boshuizen, 1993).

The student midwives at this level have formed links and relationships between facts, the task itself and patterns of specific clinical practice outcomes, which form an integrated structure of their declarative, procedural and conditional knowledge. As a result students understand the chronology of a normal birth as a whole, rather than as separate networks of birth knowledge.

The extended abstract level of understanding is the second qualitative cognitive shift in thinking and is discussed next.

Extended Abstract Level of Understanding

The *extended abstract* level of understanding represents a second qualitative *cognitive shift* in thinking (Biggs and Collis, 1989; Cantwell, 2004). In the *extended abstract* level of thinking schemas or patterns of discipline specific knowledge structures have transformed into new and more abstract knowledge structures. The change reflects a shift in capacity and competence to higher order thinking abilities and is a more sophisticated level of thinking. This higher order thinking incorporates advanced practice and expert thinking using abstracted knowledge structures to reason with and make valid and reliable judgments with greater accuracy and less effort.

Individuals think differently at this level. It is not just about more knowledge and experience. At the *extended abstract* level of thinking they have a metacognitive

awareness in the management of their thinking and problem solving (Biggs, 1998). To be metacognitively aware, the individual requires self-regulatory inquiry skills (Ertmer and Newby, 1996).

One example of this self-regulatory inquiry experts are likely to use is outlined by Pintrich (2002) as a three stage process below:

Strategic – knowledge about general strategies for learning, thinking and problem-solving,

Knowledge about cognitive tasks – ability to be adaptive and / or willing to change the method or approach to achieve any given task, and

Self-knowledge – knowledge of one's strengths and weaknesses.

(Pintrich, 2002).

This self-regulatory inquiry (strategic, task and self) assists the individual to identify missing information or inconsistencies within information by drawing on their own resources to seek and find the information. The process of self-regulation, by a conscious awareness of their cognitive processes and exerting control over thinking, is engaging their metacognitive knowledge (Schraw, 1998). Degazon and Lunney (1995) describe metacognitive knowledge as the ability to recognise, analyse and discuss thinking processes and the development of this skill '*...provides a basis for growth as a thinking professional*' (p. 272). It is multidimensional, discipline general in nature and can be taught (Schraw, 1998; Volet, 1991).

Price's (2004) description of expert midwives' critical thinking processes is similar. Midwives monitor their practice by identifying what is known about the situation or concept, monitor any known risks related to the situation and hypothesise the desired outcome by using their prior knowledge and experience of evidence-based practice. Price established midwives do challenge their assumptions about practice and results in a personal transformation of practice perspective. This self-regulatory monitoring enables midwives to respond to the complex practice in a context of uncertainty, rather than the use of the rigid decision making guidelines (see Chapter one).

The importance of higher-level thinking abilities in midwifery practice are acknowledged in the *National Competency Standards for the Midwife* (fully detailed in appendix 4). The four domains cover the all aspects of the professional midwives' discipline specific knowledge. The first domain specifies the legal and professional practice competency standards that relate to the legal and professional responsibilities of a midwife. These involve their accountability and responsibility to practice in accordance with legislation affecting

midwifery, which demonstrates their professional leadership. The second domain highlights the knowledge and practice competency standards that relate to midwifery practice. This involves the assessment, planning, implementation and evaluation of safe and effective care, in partnership with the woman. In this domain there is an emphasis on the requirement of higher order thinking processes and advanced practice skill.

For example two elements in competency unit (6) in the Midwifery Knowledge and Practice domain are measures of expert professional practice (Siddiqui, 1994) and are explained below:

Element 6.1 *'utilises a range of midwifery knowledge and skills to provide midwifery care for woman and her baby with complex needs as part of a collaborative team'*; and the relevant cue *'demonstrates a sound knowledge base of relevant disease processes and health complexities'*.

Element 6.2 recognises and responds effectively in emergencies or urgent situations; and the relevant cue, *'recognises and responds to any urgent or emergency situations with timely and appropriate intervention, consultation and /or referral'*

(ANMC, 2006 p. 5 - 6).

The third domain describes midwifery as primary health care with competency standards that represent midwifery practice as a public health strategy. The notions of self-determination, the protection of individual and group rights are the main premise in this domain. The fourth domain deals with reflective and ethical practice. This domain contains the competency standards relating to self-appraisal, professional development and the value of research.

Benner's *proficient* and *expert* proficiency practice levels are equivalent to the *extended abstract* level of understanding with attributes of the *proficient* level overlapping the *expert* level (Benner, 1984). The *proficient* nurse, who has made a quantum leap from the previous (*competent*) level of practice, has the ability to recognise clinical situations as a whole, practice within guided principles and function independently. At the *proficient* level the nurse is adept at anticipating potential problems from unusual patterns of clinical data by evaluating the alternatives from their well-structured knowledge of practice developed through years of experience.

The *expert* nurse is able to manage rapidly changing clinical situations, while attending to many other aspects of care simultaneously (Benner, 1984). They have a deep (intuitive) grasp of clinical situations and assess critical areas of a situation and know which solution

will work to reach the outcome. The experts make more inferences from relevant data for faster, more accurate decisions and skilled performance is fluid, flexible and highly proficient (Benner, 1984; Benner, Tanner and Chesla, 1996; Cioffi, 2002; Corcoran, 1986a; Patel and Groen, 1986).

Midwifery knowledge at this level of understanding has been described as professional declarative, procedural and conditional knowledge; and acknowledged midwives' intuitive knowledge and experience of working with women (Cioffi, 1998; Hunter, 2007; Kelly, 1997; Mok and Stevens, 2005; Price and Price 1997; Siddiqui, 1994). Siddiqui explained that this modern midwifery knowledge is gained through '*...established theories (declarative and procedural knowledge), research, experience, problem-solving and sometimes intuition or tacit knowledge*' (2005 p. 26). The clinical reasoning strategies of professional midwives are described as heuristics or 'rule of thumb' knowledge (Cioffi and Markham, 1997); or a 'bag of tricks' (James et al., 2003). Orme and Maggs (1993) found that decision makers often rely on a 'gut feeling' of the situation to reason. The more midwifery abstract knowledge and reasoning structures becomes embedded in past experiences, the more sets of past experience rules and abstracted schemas of clinical patterns develop (Cioffi, 1997; Cioffi, 2002; Danerek and Dykes, 2001). These fundamental elements of professional midwifery practice assist their reasoning (Benner, 1984; Cantwell, 2004; Greener 1988).

Birth knowledge is complex and wide-ranging. Midwives assessment of labouring woman's readiness to birth requires recognition of data cues to prompt prior knowledge experiences and patterns. To match data cues, a midwife questions and observes the signs (for example, the length and strength of uterine contractions), and the symptoms (whether the woman is pushing with contractions) to measure and interpret these cues. The midwife's prior knowledge of birth experience contributes to accurate understandings of the situation with the ability to predict the outcome quickly. Knowing the normal and common processes of birth, alerts midwives to the deviations from the norm, this may prompt a different action to make the clinical judgment accordingly (Cioffi and Markham, 1997; Cioffi, 1998).

All fields of expertise have common characteristics in their description of expert practice. Expertise is individual, complex and develops over time. The expert is skilled in practice and efficient which allows them to focus on other processes simultaneously. Glaser and Chi (1988) captured the expert in these generic characteristics:

- They are faster than novices at performing the skills of the discipline, and solve problems with greater accuracy and less effort;
- They have superior short-term and long-term memory;
- They see and represent a problem in their discipline at a deeper level and with more breadth than novices (for example novices tend to represent a problem at a superficial level);
- They spend a great deal of time analysing a problem qualitatively;
- They have strong self-monitoring skills and employ high levels of metacognition in their clinical reasoning;
- They possess the affective dispositions (for example inquisitiveness, self-confidence, open-mindedness, flexibility, honesty, diligence, reasonableness, empathy and humility).

The important component of expertise and skilled problem solving is the experts' discipline specific knowledge (Ericsson, 2003). With this specific discipline knowledge experts are able to think along multiple lines and at different levels at the same time and to make difficult judgements accurately. Consistent exposure to different clinical situations in practice (Ashcraft, 2001; Simon, 1980) assists in the development of quality discipline specific knowledge to reason and make accurate decisions (Azzarello, 2003, Benner, 1984; Boshuizen and Schmidt, 2000; Cioffi, 1998; Danerek and Dykes 2001; de Jong and Ferguson-Hessler, 1996; Greener 1988; Orme and Maggs, 1993; Patel and Kaufman 2000; Norman, Brooks, and Allen, 1989).

The *extended abstract* level of understanding requires higher order thinking abilities at a more sophisticated level. Higher order thinking relates to advanced practice as the expert uses their abstracted knowledge structures to reason and make accurate decisions. Their self-regulatory skills provide the bases for monitoring cognitive knowledge and practice, to account for sophisticated decision making, by being metacognitively aware.

Advanced clinical practice signifies the *expert* and expert midwifery decision making is described as intuitive: an artful model of a sophisticated synthesis of clinical and analytical knowledge. It is transformed by years of experienced practice by being metacognitively aware (Price, 2004; Price and Price, 1993; Price and Price 1997; Shaw, 2001). Readily accessible discipline specific knowledge facilitates a sophisticated decision making process. To reason clinical decisions using abstract principles are reflective of higher-

order thinking abilities (Bordage and Lemieux, 1991; Boshuizen and Schmidt, 1992; Cholowski, 1998; Patel et al., 1990; Schmidt et al., 1990).

In conclusion this sequence of developing a discipline specific knowledge base outlined how new discipline knowledge develops. A loosely structured knowledge base presents difficulties for students distinguishing between relevant and irrelevant information when considering clinical data cues.

The student midwives' knowledge and practice begin to develop depth and breadth, to their declarative and procedural knowledge structures, by connecting common pieces of information and processing them into distinct networks of midwifery knowledge networks. The networked knowledge structures develop separately initially and then become integrated with increasing knowledge and practice. Changes in thinking occur and structured cognitive knowledge networks integrate to inform students' understanding of normal birth as a whole, rather than separate structures of birth knowledge. The changes represent a qualitative cognitive shift in thinking. The students' developmental changes in thinking are assisted by constructive questioning under guidance of a more experienced mentor. This gradual transfer of relevant self-regulatory or metacognitive strategies from the mentor to the student assists the construction of a more sophisticated discipline specific knowledge. Knowledge is transformed into structures of problem representations, pattern recognition, heuristic strategies, illness scripts or schema that individuals use to reason problem solutions. Practice becomes independent and decision making ability increases with practice experiences.

From expertise new and more abstract knowledge structures develop and individuals begin to think differently, a second qualitative shift in thinking which results in higher order thinking abilities. Knowledge transforms into abstracted discipline specific knowledge structures. With this discipline specific knowledge, individuals make valid and reliable judgments with less effort and greater accuracy. The professional midwife, by being metacognitively aware, is clinically competent, advanced in practice and acts independently.

The development of midwifery students' discipline specific knowledge – the knowledge, skills and attitudes expected of a midwife (*National Competency Standards for the Midwife*) – and the declarative, procedural and conditional knowledge (theoretical types of knowledge), interconnect to explain the what, how and why of professional practice. The

relationship between these concepts and midwifery practice explains the development of student midwives' knowledge that is illustrated in figure 3.2.

midwifery competency types of knowledge	knowledge	skill	attitude
	declarative (what)	procedural (how)	conditional (when – why)

Figure 3.2: Midwifery competency and types of knowledge framework.

This knowledge framework incorporates the theoretical perspective which explored the structure of students' and midwives' knowledge used when reasoning task decisions. The interconnectivity between midwifery practice and the types of knowledge suggests the framework would appear sufficient to operationalise students' and midwives' data and demonstrate the students' knowledge growth from their first to their twentieth birth.

Chapter Summary

The transition from student to midwife was examined in this chapter. The chapter proposed the 'theoretical' sequence that systematically predicted how midwives' knowledge structures develop from novice to expert. Cantwell's theory of cognition formed the conceptual framework to substantiate the developmental changes in students' thinking. Evidence to support these developmental changes in thinking was drawn from a number of sources: the *National Competency Standards for the Midwife* (appendix four), Benner's nursing proficiency practice levels (outlined in Chapter one), midwifery knowledge, and the medical and nursing studies.

Cantwell's model represents the *acquisition*, *accretion* and *integration* of knowledge in a sequence of interconnected developmental changes that take place during the course of learning, with equivalent levels of understanding in SOLO terms. The *acquisition* of knowledge in the *uni-structural* level begins with learning declarative knowledge. Throughout the *accretion* phase knowledge develops relationships with like items of information to be categorised and is a multi-*structured* level of understanding.

A shift to the *integration* of knowledge at the *relational* level of understanding is the first '*cognitive shift*' in thinking and knowledge becomes more generalised. Finally the *exit*

point equates to the *extended abstract* level of understanding the second '*cognitive shift*' (Cantwell, 2004). This level is characterised by a high level of abstract thinking which enables individuals to take in new and more abstract information, and generalise their new knowledge within existing knowledge structures.

These levels of understanding have similarities either in description or in developmental changes with the *National Competency Standards for the Midwife, Model of Professional Nurse Development; midwifery knowledge* categories; and *medical and nursing studies* (ANMC, 2006; Benner, 1984; Biggs and Collis, 1989; Cantwell, 2004).

The *National Competency Standards for the Midwife* literature did not clearly define the development and structure of a midwifery knowledge base. However competency standard's role in learning and performance criteria, the regulatory framework of professional midwifery practice, was part of the evidence to substantiate the on-going integration and structure of midwives' discipline specific knowledge.

The *Model of Professional Nurse Development; midwifery knowledge* categories; and *medical and nursing studies* literatures were grouped to illustrate similar characteristics and parallels with Cantwell's knowledge acquisition model. These representations demonstrated how the development of students and midwives' discipline specific knowledge base takes place at various levels. Midwives' discipline specific knowledge contains declarative, procedural and conditional knowledge.

Declarative knowledge develops throughout the knowledge *acquisition*, a *uni-structural* level of understanding parallels the characteristics of Benner's *novice* level. With this beginning declarative knowledge the students' are assisted and often supervised with their developing practice tasks. This limited practice and loosely structured knowledge is incomplete and result in weaker knowledge associations and unsuccessful reasoning outcomes.

Increased declarative knowledge and its application in practice changes the students' thinking during the *knowledge accretion* phase, a *multi-structured* level of understanding and parallels Benner's *advanced beginner* practice level. Students' knowledge develops a depth and breadth to its structures. Categories of common pieces of information form relationships that link these developing structures. Across the *knowledge accretion* and *advanced beginner* levels thinking changes from remembering information to knowing

information often with the assistance of a clinical mentor. At this level of knowledge development the students' procedural knowledge is also developing. Practice is task-orientated. Students' reason data cues using their declarative knowledge however are less likely to grasp variations within situations. There are individual differences in students' rate of development in thinking and some may begin to show signs of knowledge *integration*.

Cantwell's *knowledge integration* equates to a *relational* level of understanding and parallels Benner's *competent* practice level. At this level there is a qualitative shift in thinking. The shift transforms their declarative and procedural knowledge into schemas or patterns of discipline specific knowledge structures and clinical practice outcomes. Throughout this phase students' begin to acquire a deeper understanding of the 'when' and 'why' of their thinking when making judgments and reason decisions. This is their conditional knowledge that develops through growth and integration of declarative and procedural knowledge.

Across the *knowledge integration* and *competent* practice levels students' are classified as skilled responsible clinicians whose practice is independent. At these various levels of expertise clinicians reason with their integrated patterns prior knowledge. Increased knowledge and experience continues to integrate and restructure patterns of knowledge into an abstracted form during the first cognitive shift in thinking.

The *extended abstract* level of understanding parallels Benner's *proficient* and *expert* level of practice proficiency and represents the second cognitive shift in thinking. The shift signifies higher order thinking abilities at a more sophisticated level and advanced practice expertise. Self-regulatory skills provide the bases for monitoring knowledge and practice, which enables sophisticated decision making through metacognitive awareness.

The evidence from these literatures have demonstrated that the characteristics of knowledge development described from the Cantwell model has clear parallels in the National Competency Standards for the Midwife, Benner's model, midwifery knowledge, and the medical and nursing studies. Therefore it is a sound theoretical framework that to explain the development of a discipline specific knowledge base. This documented sequence of discipline specific knowledge has been consistent with the Cantwell's knowledge acquisition model.

Chapter four outlines the study's design of the protocol analysis methodology. The first part of the chapter describes the study subjects, the development of the structured interview schedule, the method of data collection and its transfer into written data including procedures used to transfer data into verbal protocols for analysis. The study's coding method is connected with the study's theoretical framework and finally, there is discussion of the types of data analysis selected to realise the study's aim.

CHAPTER FOUR: THE STUDY METHODOLOGY

Chapter three proposed a theoretical sequence that systematically predicted the development of midwifery students' discipline specific knowledge and described the structure of experienced midwives' discipline specific knowledge base. The aim of this study is to understand how these developmental changes in thinking transform the structure of individuals' knowledge. The midwifery practice literature, midwifery competency standards, Benner's nursing proficiency practice levels and Cantwell's theory of cognition from the cognitive sciences literature provided the basis for the development and structure of a midwife's hypothesised knowledge.

This chapter outlines the study's methodology. The first part of the chapter introduces the study design incorporating a description of the participants. The study's ethical considerations are presented next, followed by the data collection materials, with sections on the structured interview and its relationship to the birth task, and then the data collection and preparation procedures. The remainder of the Chapter describes the design of the protocol analysis, the coding scheme employed to categorise and quantify students and midwives' verbal protocol segments, and finally an account of the techniques selected to examine the study's data.

Study Design

This is a qualitative study with elements of quantitative analysis to answer the research question from evidence to be obtained as explicitly as possible (de Vaus, 2001). The students and midwives were asked what they were thinking, doing and saying while performing a normal birth. In order to understand how students' knowledge develops as they gain their knowledge, skills and attitudes compared with midwives' knowledge the study by the following three questions:

- 1) What is the nature of the differences between midwifery students (after their first and twentieth birth) and experienced midwives in their use of declarative, procedural and conditional knowledge when making clinical decisions during a normal birth?
- 2) What is the nature of midwifery students' discipline specific knowledge after their first and twentieth birth when making clinical practice decisions?
- 3) What is the nature of experienced midwives' discipline specific knowledge?

The method for identifying cognitive human thinking using verbal reports, and preparing data in the theoretical framework for a protocol analysis technique, are derived from cognitive psychology (Ericsson and Simon, 1993; Ericsson and Simon 1984; Gall, Gall, and Borg, 2007; Hassebrock and Prietula, 1992). Verbal protocol analysis is an acknowledged way of providing accurate and representative measures of cognitive processes when performing a task (Ericsson, 2007; Ericsson and Simon, 1993). Elstein and colleagues (1990) found protocol analysis can identify specific items, either a significant clinical phrase, or phrase within the data, which are the reference points of subjects' knowledge and thinking processes. Data are prepared into verbal protocol segments, and a coding scheme provides the set of rules to categorise and subsequently measure students' and midwives' verbal protocol segments. Many researchers in the field of clinical reasoning have made use of the protocol analysis method; therefore it is suitable for this study (Balla et al., 1990; Ericsson and Simon, 1993; Grant and Marsden, 1987; Kassirer and Kopelman, 1989; Patel, Groen and Norman, 1993; Patel and Groen, 1986; Schmidt and Boshuizen, 1993).

Two different procedures for collecting verbal reports of task-orientated cognitive processes are think-aloud reports and retrospective verbal reports. Think aloud reporting involves simply '*...verbalising new thoughts as they enter attention as part of the normal sequential thought process of performing a task*' (Ericsson and Crutcher, 1991 p. 66). The second procedure – retrospective verbal reports – describes how '*...subject focuses on the task until its completion and then recalls, as accurately as possible, the sequence of thoughts that occurred while doing the task*' (p. 66). Retrospective data are combinations of short-term memory (STM) and long term memory (LTM) where triggers to the STM prompt LTM thoughts (Ericsson and Simon, 1993; Newell and Simon, 1972).

Retrospective verbal reports are the choice of data collection for the study because the task being examined was in 'real time' clinical practice. Ericsson and Simon describe that retrospective reports are useful where '*...perceptual-motor tasks with real-time constraints*' (1993 p. xvi) are involved and concurrent think aloud verbalisations may interfere with the task. In the case of performing a normal birth task a midwife is focussed on the birthing process throughout in planning, monitoring and evaluating the care of woman and her baby.

In this practice environment a midwife's focus is on the task because the complexity of birth requires her to anticipate the care and safety of the woman and her baby with limited interruption. She will be concentrating on data cues, and interpreting outcomes within real time constraints. Even though the students are learning in this clinical setting, and their practice is supervised, they will have the same practice requirements with the task. The nature of every birth is unique. Students and midwives' practice and decision making are guided by a woman's individual needs. However the practice setting is not unique: it is shared by many students, midwives and other health professionals.

The method of using retrospective verbal reports was selected so as not jeopardise the safety of the woman during the delivery of her baby because the task, with its time constraints, and practice setting is far too complex for a think aloud method of data collection.

Retrospective data collection of recall from real time practice is structured because it does not disrupt the basic nature of thinking (Crutcher, 1994). Recalled sequences of thoughts '*...can be reported with high accuracy...(and the)...memory for the reported information is strengthened*' (Ericsson and Simon, 1993 p. xxxii) by this process. A structured interview format was selected as the data collection instrument. It is based on the chronology of birth, a retrospective report condition that would ensure the recall of the task did not interrupt the subjects' thinking pattern and to avoid any interpretation of the recalled data (Ericsson and Simon, 1993).

The pre-determined questions were designed to generate free answers and provide the short term memory triggers for retrieval of information (prior knowledge) from the students and midwives' memory (Bainbridge, 1999). The aim is to prompt recall of what they were actually thinking and doing throughout the task. The clarity of instructions and the researcher's familiarity with the task satisfies the internal consistency and validity of data collected (Elstein et al., 1990; Ericsson and Simon, 1993; Grant and Marsden, 1987). Ericsson and Simon suggest incorporating a 'warm-up' task to begin the collection of retrospective reports because this additional retrieval of the memory trace will link the subjects' thinking to recall the task (1993 p. xxi). A 'warm-up' task is included in the study at the beginning of the interview.

Study Participants

Two groups of participants were recruited. The first group consisted of midwifery students enrolled in a Graduate Diploma of Midwifery program at a regional University in Newcastle Australia (a midwifery student is required to master 20 normal births to complete their program and will have witnessed five normal births prior to performing their first normal birth of a baby). The second group are experienced midwives, members of staff working in a delivery suite of a tertiary referral hospital in the same geographic area as the University (performing a normal birth is a principal part of their role).

Group one, the midwifery students were interviewed on two separate occasions. The first interview took place at the beginning of the student's program and within three days of performing their first normal birth of a baby. After the students' twentieth normal birth of a baby the second interview also took place within three days. Group two, the experienced midwives were also interviewed within three days of performing a normal birth as part of their practice.

The student midwives in the study were recruited with permission from the University's Faculty of Nursing, via the Diploma of Midwifery program coordinator who introduced the researcher to the group. The researcher gave a presentation outlining details of the study and all students received an information package inviting them to participate in the study. This procedure was repeated with each subsequent Diploma group until a sample of 18 was obtained. However, only 15 student midwives participated in the second interview, the remaining three did not complete the study due to a failure to meet their program assessment requirements. The experienced midwives from the hospital, with two or more years of consecutive experience birthing women, were also invited to participate in the study. There were 48 who met the study criteria and 12 agreed to participate in the study. Table 4.1 below summarises the students and experienced midwives who participated in the study.

Table 4.1: Study groups: student and experienced midwives.

Group	Participants	Interview	N
1	<i>Student Midwife:</i> First normal birth, in a Diploma of Midwifery	1	N=15
	<i>Student Midwife:</i> Twentieth normal birth, in a Diploma of Midwifery	2	N=15
2	<i>Experienced Midwife:</i> A normal birth of a baby	1	N=12

The opportunistic sample of students and midwives were female and a summary of their demographic profiles appears in table 4.2 below.

Table 4.2: Students and midwives demographic profile

Characteristics	Students N=15	Midwives N=12
<i>Years of midwifery experience</i>		
Average		16
<i>Years of RN experience</i>		
< 4	5	9
5-10	4	3
>11	3	0
Average number of years	5.7	3.6
<i>Participants' age</i>		
<24	2	0
25-34	10	2
35-44	3	5
45-54	0	4
>55	0	1
<i>Qualification - undergraduate</i>		
Nursing Certificate	3	12
Diploma of Nursing	4	0
Bachelor of Nursing	8	0
<i>Post Graduate</i>		
Graduate Diploma in Midwifery	0	2
Masters	0	3
<i>Current Award Position</i>		
Student Midwife	15	0
Certified Midwife	0	3
Clinical Nurse /Midwife Specialist*	0	9

*Clinical Nurse Specialist (CNS) is a Nursing Award position of specialty experts and included midwives; however in 2000 the position of Clinical Midwifery Specialist (CMS) was created for expert midwives.

Ethical Considerations

Ethical clearance and approval to conduct the study in an Australian tertiary referral hospital was granted by the relevant Ethics Committee. Permission was granted to recruit the experienced midwives and midwifery students by the Department of Obstetrics and Gynaecology, at the tertiary referral hospital, and the Faculty Head of the University, respectively.

Participation in the study was voluntary. An information package was provided which contained a formal letter stating the nature of the research to ensure participants were fully informed of the study details and that no misunderstanding occurred (Keats, 1988). Those who did formally consent were subsequently interviewed, and also gave permission for the use of their data in reports or publications arising from the study.

Participants were advised they were able to ask for clarifying information at any stage of the process and were able to withdraw from the study at any time without explanation. Assurances were given that their confidentiality would be protected. To ensure anonymity pseudonyms were used in all reports of the data.

The design of the structured interview incorporates the data collection materials and procedures used to develop the structured interview schedule, all of which are described next.

Development of Data Collection Materials

The Structured Interview

The research questions asked:

- 1) What is the nature of the differences between midwifery students (after their first and twentieth birth) and experienced midwives in their use of declarative, procedural and conditional knowledge when making clinical decisions during a normal birth?
- 2) What is the nature of midwifery students' discipline specific knowledge after their first and twentieth birth when making clinical practice decisions?
- 3) What is the nature of experienced midwives' discipline specific knowledge?

Retrospective data was collected using a structured interview designed to mirror the chronology of the birth process. The design standardised the sequence of the birth in four phases (assessment, delivery, after birth and reflection) in order not interrupt the flow of the students' and midwives' thinking (Ericsson and Crutcher, 1991; Ericsson and Simon, 1993). This method of collecting retrospective data ensured undistorted verbal reports because the thought processes of the students and midwives were focussed directly on

the recall of the task (Bainbridge, 1999; Ericsson and Simon, 1993; Hassebrock and Prietula, 1992). Their recall of the task confined to the chronology of the birth led to the collection of reliable and valid data.

The structured interview questions were prepared by using a midwifery curriculum and midwifery texts (Beischer and Mackay 1988; Bennett and Brown, 1999; May and Mahlmiester, 1990; Olds et al., 1980; Raphael-Leff, 1991). The chronology of the birth compared the particular processes and procedures that involve the mechanism of labour and birth and the relevant midwifery care responses. These specific processes and procedures mark the reference points in the data that will identify the students and midwives' knowledge, skills and attitude.

Chronology of the Birthing Process

The chronology of the birthing process is a blend of pathophysiological (declarative) knowledge of birth that prompts the skilled responses (procedural knowledge) expected of the midwife. The essential pathophysiological or declarative knowledge of birth involves the anatomy and physiology of woman, specifically the pathophysiology of the uterus and cervix, the changes that occur throughout pregnancy, labour and delivery. Knowledge of foetal and newborn anatomy is needed to understand the relationship between baby's normal growth and gestational age, which involve the development from foetus to newborn, the pathophysiology of the circulatory system and its relationship to the maternal blood supply. With this declarative knowledge a midwife can recognise normal labour and birth. Midwifery care behaviours and skills in performing the task rely on the comprehensive declarative knowledge that is integrated with procedural knowledge. The pathophysiology of normal labour in its three stages is outlined next.

Stages of Labour

The first stage begins with the onset of labour and is finished when the uterine cavity and vagina are no longer separated by a rim of cervix. The second stage is the delivery of the baby, and the third stage is the expulsion of the placenta that represents the after birth phase.

In the first stage of labour, and with continuous uterine contractions, the foetal head progresses into the birth canal, until woman's cervix dilates to nine centimetres; from nine centimetres to full dilation of the cervix is known as the transitional stage. The continuous

pattern of regularly occurring uterine contractions initially experienced as mild, progress from mild to moderate and then to intense as labour progresses through this first stage. The first stage of labour is divided into latent and active phases, woman's cervix begins to 'take up' and 'dilate' with the possibility of membrane rupture during this time. For a woman having her first baby this stage may be 12 to 18 hours in length; with the second and subsequent labours this stage is usually shorter. The woman's readiness to deliver her baby is determined by assessing baseline history, from progression in the first stage of labour and her previous birth history.

The second stage of labour begins at the full dilation of the cervix and ends after the birth of the baby. Throughout this stage the foetal head continues to flex and will have reached the ischial spines, a landmark in the pelvis. In the next movement, internal rotation of the head occurs, allowing the head to extend through the birth canal.

The baby's head is delivered by maternal effort and guided by an accoucheur (in this study a student or a midwife). External restitution of the head takes place as it returns to align itself with the shoulders. The shoulders are delivered on the next uterine contraction, with a downward foetal axis pressure used to release the anterior shoulder from under the symphysis pubis of the pelvis, and then in an upward direction in a continual curve, delivering the trunk and legs, then baby is placed onto the woman's abdomen.

The *delivery phase* is the stage in which the midwife is required to recognise data cues and act accordingly. The process of birth can change suddenly and requires a knowledgeable, skilled midwife to anticipate and make accurate care decisions quickly. The skill (procedural knowledge) of the task is a primary focus in this phase. The progression of labour and the knowledge and skill of the midwife assists the woman to birth. Midwives' interaction with woman during her care is also an important factor during the delivery phase.

The third stage of labour begins after the baby is born and ends with the expulsion of the placenta. During this stage, the baby's cord stops pulsating and is clamped and cut. The sign of separation of the placenta from the uterine wall occurs and the placenta delivers.

In the *after birth phase* the midwife is required to have the knowledge and skill associated with the delivery of the placenta. Her knowledge is based on linking the woman's data cues with the method of delivering the placenta and being prepared for sudden changes. It is now, when the midwife has both the woman and her baby in care, that her interactive

relationship with the woman is important in the maintenance of care (see appendix 6 for a detailed description of the mechanisms for delivering the baby and placenta; and appendix 7 for the specific physical and psychological care responses in normal birth).

The chronology of the normal birth, described in three stages of labour, strengthened the design of structured interview questions by directing a logical sequence to the collection of comparable data for analysis from the diverse groups of students and midwives. The interview schedule is outlined next.

The Interview Schedule

The interview began with a warm-up task which asked the subjects to recall details of the delivery. These first six questions were prompts for students and midwives to recall the specific birth outcomes. The prompts included how long was the labour? Was the baby female or male? What were the baby's apgar scores? These prompts acted as memory retrieval cues for participants when selecting the sequence of events from a vast amount of information (Ericsson and Simon, 1993) by orientating the students and midwives and directing their thought processes to the birth. This prompt to set the scene for interview questions and data did not form part of the analysis.

The students and midwives were then asked what they were thinking and doing during each phase to determine their knowledge (declarative knowledge), skill (procedural knowledge) and attitude (conditional knowledge) used in the task (see Appendix 8 the structured interview format). The questions are listed below in numerical order and in the assessment, delivery and after birth phases (outlined above):

Assessment

- 1) How did **you** know the woman was ready to deliver her baby and what assessment did you make?
- 2) What was the reason **you** decided she was ready to deliver her baby?
- 3) Did you make a plan for the delivery?
- 4) How did **you** prepare for the woman's delivery?
- 5) What were **you** thinking about while preparing for the delivery?

Delivery

- 1) During the delivery what went through **your** mind?
- 2) During the delivery what were **you** doing?
- 3) During the delivery what did **you** say to the woman?

After Birth

- 1) At this time, what were **you** thinking?
- 2) After the baby was born, what did **you** do for the baby and the woman?

3) What did **you** talk to the woman about?

After the birth and expulsion of the placenta, the students and midwives were asked a further three questions. Even though not a major phase in the birth process the questions provided the opportunity to reflect on their thinking and actions with the overall birth process. The students and midwives were also asked to reflect on their knowledge of the birth process.

Reflection

- 1) Do **you** remember any aspects of the delivery that caused **you** to change your plan?
- 2) Now that **you** have the opportunity to review the process, do **you** have any concerns that **you** care to discuss?

Knowledge

- 1) How did **you** know what to do during the delivery?

Questions were also prepared to prompt recall if needed, for example; did the woman's actions cause you to act differently than you had planned? What were the cues that led you to that decision? Did you have any alternative actions or strategies? Figure 4.1 below draws together the structured interview schedule by illustrating how three data sets (two student midwives and one experienced midwife) link the phases of the task and illustrates how they relate to the numbered declarative, procedural and conditional knowledge questions.

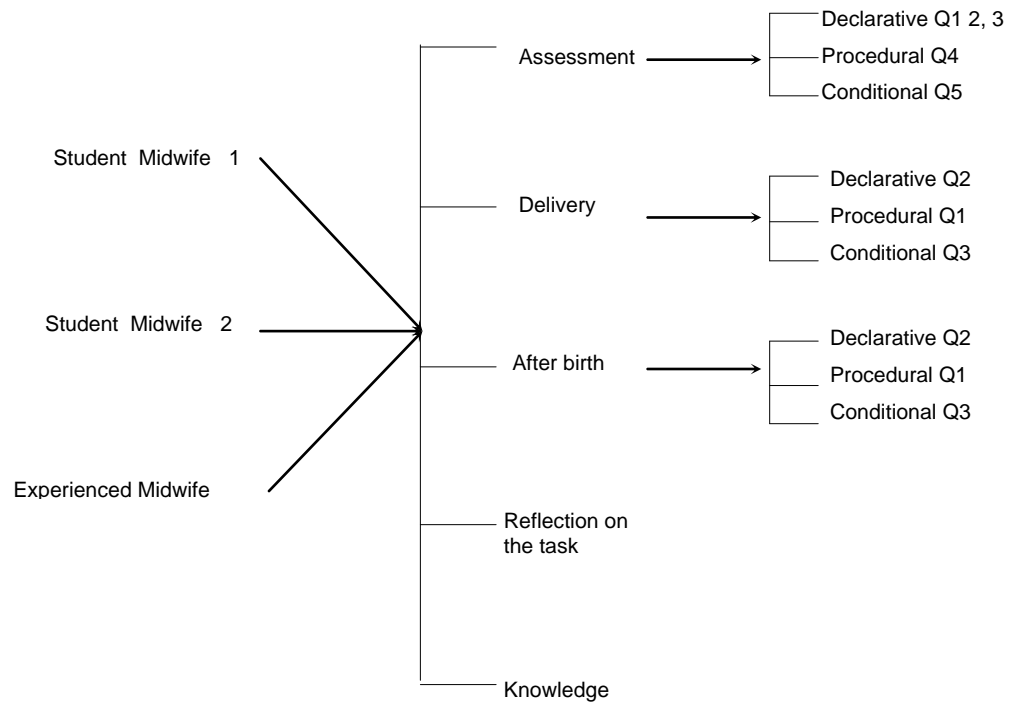


Figure 4.1: The framework of the structured interview.

Data Collection and Preparation Procedures

Individual interviews with the researcher were conducted in private at a mutually agreed time and place. Each interview was undertaken within 72 hours of performing the task. The average time for each group: students (first birth) 43 hours; students (twentieth birth) 34 hours; and midwives 36 hours, from the birth to interview respectively (see Appendix 9 for the details of the interviews). At the beginning of each interview, students and midwives were advised it would take no more than 45 minutes of their time (including completion of a demographic questionnaire). The audio-tape was turned on and the interview commenced. The students and midwives were asked to recall the birth task in the same manner, to ensure consistency in data collection.

The audio-taped interviews were later transcribed for analysis (Ericsson, and Simon, 1993). All students and midwives were given the opportunity to edit their interviews. The contents of the transcripts were compared with the audio-taped interviews to verify the accuracy of the transcribed data. Finally, all identifiers were removed and each transcript

was given a code number and a pseudonym. The data were then prepared for analysis and this process is described next.

Data Management

The raw data contained all the pauses and repeated phrases, along with the colloquial language. Syntactic breaks were noted and the commas and pauses were noted with dashes (Hassebrock and Prietula, 1992). The contents of the transcripts were then read and compared to the audio-tape recording to verify the accuracy of the transcribed data.

Preparation for Coding

The procedures used to transform the verbal data into a suitable form for analysis began with each student's and midwife's transcribed data. The transcribed data were in the assessment, delivery, after birth, reflection and knowledge topics sourced directly from the structured interview schedule. Data within each of these larger topics were prepared independently by identifying a single referring word, or phrase that referred to a discrete concept in the topic. The words or word concepts of a phrase were then examined to identify their relationship to a topic in the task and its association with the chronology of the birthing process (describe above). The researcher then established that data demonstrated a relationship to the birth process and matched the related topic. This part of the data then became a verbal protocol segment. To explain the process, an example from Lorraine's (student's twentieth birth) verbal data is used, and as she recalled what she was thinking (after birth phase) describes:

Um, I don't know. (Long pause) I can't think of anything that I was thinking of. Um, Like I wasn't worried about anything, yeh. Everything was fine and normal so um, yeh. I was thinking I guess that everything was fine, normal, healthy baby, mum was okay so. So yeh that was probably all. I wasn't worried or concerned about anything. Yep.

The first step in the process established that Lorraine was rationalising her thoughts and the topic was in the after birth phase. The next step in the process deleted all repeated words, colloquial language and pauses and this highlighted the concept of the segment, the outcome of birth, as explained in her words below:

I was thinking I guess that everything was fine, normal, healthy baby; mum was okay...I wasn't worried or concerned about anything.

This example was then ready for coding. All participants' verbal data were prepared into segments for coding in the same manner with each protocol segment represented as a topic within the larger birth phase. The same process was applied to each of the larger birth phase topics (assessment, delivery and after birth), transforming the verbal data into a suitable form for coding and subsequent analysis (Ericsson and Simon, 1993; Hassebrock and Prietula, 1992; Isenberg, 1986). A sample of the data from students (first and twentieth birth) and midwives illustrating the outcome of these two steps in the process of preparing data for coding appears in Appendix 10.

This method of preparing longer protocols into shorter segments in order to '...be coded more or less independently' (Crutcher, 1994 p. 243) may hinder some context however Crutcher suggested this will decrease subjectivity and that '*...any segment used to help another segment can no longer be considered an independent observation*' (p. 243). Hassebrock and Prietula (1992) encountered these difficulties when coding the health professional's clinical reasoning data and for that reason the current study's rigorous preparation of protocol segments provided data with sufficient meaning to be coded independently (Bainbridge, 1979; Bainbridge, 1999; Crutcher, 1994).

All data sets were prepared by the researcher. This preparation included the collection of data by audio tape, transcribing and proofreading and the preparation of data into protocol segments. These strategies enhanced the validity of the data collection and consistency in the interpretation of data (McMillan and Schumacher, 2006). A total of 4154 protocol segments were identified in the three data sets. The number of students' and midwives' protocol segments is listed below in table 4.3.

Table 4.3: The number of verbal protocols: total = 4154

Data Sets	Number of verbal protocols
Students' first birth	1369 protocol segments
Students' twentieth birth	1593 protocol segments
Experienced midwives	1192 protocol segments

To categorise and analyse the students' and midwives' verbal protocol segments a set of rules was developed for mapping the verbal data, called a coding scheme (Crutcher, 1994). The coding scheme utilised the framework of midwifery practice competency standards of knowledge skill and attitude and knowledge types to code the students' and midwives' verbal protocols and is detailed next.

Coding Scheme

The protocol analysis coding scheme for this study is complex. The coding scheme was designed to specifically capture the knowledge, skills and attitudes used by students and midwives when performing the birth task. In the clinical reasoning and decision making studies, discussed in Chapter Two, a coding scheme was also used in the interpretation of data to reflect the structure of knowledge (Balla et al., 1990; Corcoran, 1986a; Corcoran, 1986b; Ericsson and Simon, 1993; Fowler, 1997; Grant and Marsden, 1987; Patel and Groen, 1986; Tanner et al., 1987). Studies using protocol analysis highlighted that links made between clinical data cues and a prior knowledge, which individuals can readily access is important in the reasoning (Balla et al., 1990; Hassebrock and Prietula, 1992; Patel and Groen, 1986; Tanner et al., 1987). Boshuizen and Schmidt, (1992) found the use of protocol analysis techniques enabled the classification of knowledge structures for various levels of expertise. Of particular importance in this study's design was developing coding categories that measure the degree of expertise in three levels (student groups and one midwives' group). In order to do this each coded verbal protocol segment was assigned a score to indicate its degree of relevance to the task.

The coding scheme's three major categories, divided into sub categories, were based on the study's theoretical framework outlined in Chapter Three (figure 3.2). The framework devised from the knowledge, skills and attitudes expected of a midwife, (the general competency standards for a midwife), and the declarative, procedural and conditional knowledge (theoretical types of knowledge), interconnect to explain the what, how and why of professional practice. Operational definition statements were created for each category and sub category. The operational definitions were used to uphold the coding decisions and rule out the possibility of any ambiguity or inconsistency in the coding application (Ericsson and Simon, 1993; Hassebrock and Prietula, 1992).

The major categories were history, action and rationalise. The history, is used to assess woman ('woman's history' is a common term used in the practice setting); action, which describes taking valid actions based on the clinical cues; and rationalise, where the midwife thinks through her actions during the birth as she recalls the event.

An outline of the study's coding scheme, coding categories, the sub categories and types of relevance to determine the quality of the students' and midwives' protocol segments, appears in figure 4.2 below.

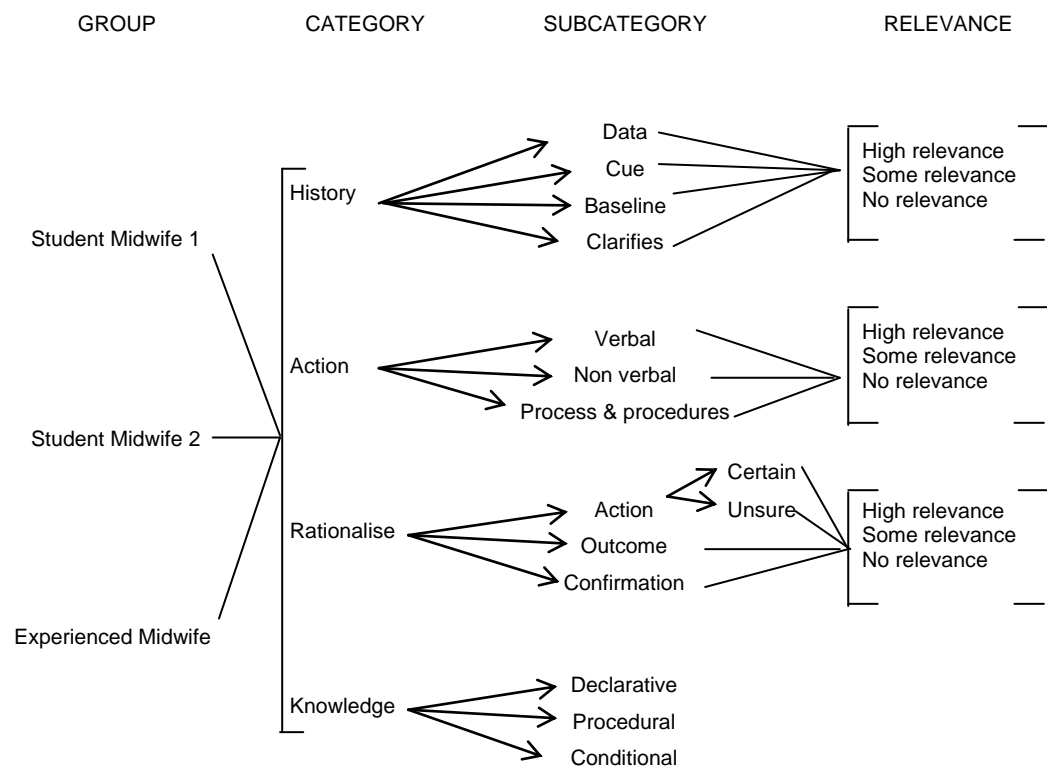


Figure 4.2: Coding scheme

The history, action and rationalise categories, and the sub categories along with their operational definitions are explained next. In order to illustrate each category selected examples of students' and midwives' verbal protocol segments, each with its nominated degree of relevance to the task: (no relevance (1), some relevance (2) and high relevance (3) are used.

History Category, Sub Categories and Operational Definitions

The first major category is history with its four sub categories:

- **History data:** gave objective information on the clinical status of the woman in building a history pattern, for example, student (Coral after her twentieth birth) identifying woman's current history data

- *'...she had started off (the labour) with the syntocinon according to her protocol' (3).*
- **History cue:** categorise information which featured in the construction of a woman's history, for example, an experienced midwife (Lilly) assessing the woman's behavioural cues
 - *'...the woman was actively distressed and moving around the bed' (3).*
- **History baseline:** representing a critical cue which anticipates action and is connected to a woman's history, for example, a student (Emily after her first birth) identified a critical cue in the woman's readiness to deliver in the assessment phase,
 - *'...because I could see the (head) crowning' (3).*
- **History clarifies:** explores the value of the relationship and interpretation of the baseline data towards a woman's history, for example, an experienced midwife (Doris) linking the woman's past history that would predict care decisions
 - *'...piece of her history was that at the last birth she had an episiotomy that went to a 3rd degree tear' (3).*

The history category captured data that related to students' and midwives' knowledge and how it was used in the task. Most of the coded history data segments fell into the assessment phase of the task. In this category, taking woman's history relies on a midwife's declarative knowledge to interpret clinical data in order to make a decision of care.

Action Category, Sub Categories and Operational Definitions

The second major category in the coding scheme is the action category which contains three sub categories.

- **Action verbal:** talking with a woman, negotiating care and discussing options of care and interpreting cues with a woman, for example, an experienced midwife (Vikki) talking with the woman

- *'...I actually just said things like, let it come gently, don't push hard, trying to be sort of a bit slower, which she did, she was really in control' (3).*
- **Action non-verbal:** describing their behaviour and / or women's cues associated with care decisions, for example, a student (Kate after her twentieth birth) linked a care decision
 - *'...put her onto her all fours position just to lessen perennial trauma' (3).*
- **Action process and procedures:** the students and midwives describe their method of performing a skill associated with the task, moving equipment required when performing the task or learning the task. For example, the student (Joanne after her first birth) described her actions immediately after the baby was born
 - *'...I clamped the cord and we just waited for a while' (3).*

The action category captured data that were related to the students' and midwives' skilled performance and competence. In this category, the students and midwives' coded verbal protocol segments reflected their practice and craft knowledge, and knowing the critical cues that require action in the delivery and after birth phases of the task. The students and midwives described their actions and non-verbal behaviour when talking and negotiating with others during the procedural processes in the task. Skilled competence is a prerequisite to performing the task and may be termed as procedural knowledge.

Rationalise Category, Sub Categories and Operational Definitions

The third major category in the coding scheme has three sub categories; rationalise action (sub-divided into certain or unsure), rationalise outcome and rationalise confirmation.

- **Rationalise action certain:** students and midwives are certain in the interpretation of their thoughts and actions during the task, for example, an experienced midwife (Vikki) rationalising her actions after the delivery of the placenta
 - *'...we wanted to keep her fundus contracted ... then her uterus became quite firm, I was massaging it for probably 15 minutes after the placenta delivered (3).*

- ***Rationalise action unsure:*** students and midwives identified that they are unsure of their actions and behaviours during the task. For example a student (Gladys after her first birth) described her thoughts
 - ‘...I was going through...the actions that I would have to do in sequence...so that I could remember to do it at the time because I was excited and nervous’ (2).

- ***Rationalise outcome:*** after reviewing the verbal data, non-verbal data or the process, students and midwives rationalised the outcome. For example, a student (Dora after her twentieth birth) explained her concerns after the birth
 - ‘...I was a little bit worried about bleeding ... she hadn’t had any signs of bleeding at all until I stood her up about an hour later ... that (*had*) settled fairly quickly (3).

- ***Rationalise confirmation:*** the task has been supported by the action and or knowledge of another midwife or a doctor. For example, from a student (Joanne after her first birth) describing a midwife’s support with a part of the delivery
 - ‘...the midwife reminded me to clamp the cord straight away so that we could have the baby over to the resuscitation trolley (2).

The rationalise category captured students’ and midwives’ protocol segments as they thought through their actions during the birth and after the event. The coded verbal protocol segments related to task activities, questioning behaviours, and identifying any unnecessary procedures and processes. The category also captured the support of their knowledge and skills they may have been given from a midwife or doctor during the birth. This category will illustrate the students’ and midwives’ conditional knowledge of their data.

Relevance, Sub Categories and Operational Definitions

The coded verbal protocol segments in the history, action and rationalise sub categories were assigned a degree of relevance to the task. The number assigned to measure all protocol segments (see examples of coded protocol segments above) could be high relevance **3**, some relevance **2**, and no relevance **1**. The relevance measures with their operational definitions are presented below.

High relevance: evidence of knowledge shown in the task decisions of birth; understanding the needs of a woman, while managing the birth illustrates quality knowledge;

Some relevance: some evidence of understanding the process but which required some confirmation and prompting from another person;

No relevance: where there is little or no evidence of understanding the task or decisions necessary to birth, and requiring guidance from a supervisor.

The selected sample of students and midwives' data showing the development of their raw data into protocol segments (see Appendix 10) are coded and given a relevance score (see Appendix 10a). Finally the types of knowledge category and their operational definitions are outlined next.

Types of Knowledge and Operational Definitions

Three categories of knowledge types are:

- 1) *declarative knowledge*, describing objective factual scientific knowledge;
- 2) *procedural knowledge* which incorporates declarative knowledge in its application of knowing how a task is performed;
- 3) *conditional knowledge* which is developed through the continual growth of an individual's declarative and procedural knowledge, and is the when and why of this knowledge.

Declarative knowledge is the individual's factual and theoretical knowledge that provides the foundation of a discipline specific knowledge. An example of declarative knowledge is explained by a student (Sasha after her first birth)

'...with the shoulder dystopia I do remember what to do with that because our lecturer did demonstrate quite graphically on the table at Uni what to do with shoulder dystopia'.

Procedural knowledge combines the skills and actions of a task with declarative knowledge to demonstrate an individual's practical expertise and professional craft knowledge. A student (Judy after her twentieth birth) explained her skills delivering the baby's head

‘...what you protect (is the baby’s head) and if you touch and if you don’t...most people tend...to maintain a bit of flexion on the head...and protect...the head sort of coming out...(in a) controlled pace with your hand’.

Conditional knowledge is an individual’s professional discipline specific knowledge developed through continual growth, the when and why of their declarative and procedural knowledge. An experienced midwife (Anita) explains how the nature of her knowledge developed

‘...midwives’ techniques...actually did teach me a lot about different techniques for delivering babies...not just my hands on experience, but watching other midwives with women...much later in my career, of having the confidence to have that knowledge behind me’.

The coding categories were used to make decisions on how students’ and midwives’ verbal protocol segments were coded independently in a form suitable for analysis. The coding categories history, action and rationalise are connected with the theoretical framework (see chapter three figure 3.2) devised from the knowledge, skills and attitudes expected of a midwife (the general competency standards for a midwife); and the declarative, procedural and conditional knowledge (theoretical types of knowledge) to explain the what, how, when and why of professional practice. The relationship between the coding categories, midwifery practice competency standards and knowledge types will be used to explain the development of student midwives’ knowledge and is summarised in figure 4.3.

Midwifery competency	knowledge	skill	attitude
Types of knowledge	declarative (what)	procedural (how)	conditional (when – why)
Coding categories	history	action	rationalise

Figure 4.3: Midwifery competency, types of knowledge, and coding categories

The next part of the chapter begins with the processes of preparing students’ and midwives’ coded verbal protocol segments for the analysis, followed by a discussion of the techniques employed to analyse data.

Data Analysis Methods

Preparing Data for Analysis

The students and the experienced midwives realised three sets of data; two sets of students' data (after their first and twentieth birth) and one set of experienced midwives' data. All groups' data were prepared into verbal protocol segments (described above) for the analysis. Each protocol segment was coded by the researcher using the study's coding tool (appendix 11) and given a score for relevance. At the end of the procedure assistance was sought from an independent reviewer to verify the researcher's coding and 126 inconsistencies were highlighted, with a confidence level of 97%.

All inconsistencies were resolved through a discussion with the independent reviewer and researcher. The inconsistent codes were in the rationalise category. While the history and action categories were straightforward, the rationalise category was more complex. Of the three sub categories, the rationalise action has a further two, certain and unsure. Clarity in the meaning of the words appeared to be the problem and all inconsistencies were resolved in the discussion using the chronology of birth reference points and the code scheme's operational definitions. Finally, to validate the coded protocol segments an additional audit was conducted across twenty per cent of data sets by a peer researcher. There was agreement on all coded protocol segments and the three sets of coded data were ready for analysis.

Four Excel (Microsoft Office Excel, 2003) spreadsheets were prepared to enter the coded protocol segments from each participant. One Excel data sheet was developed for all birth phases, that is the assessment, the delivery, the after birth, and the reflection phases. On all four spreadsheets the respective code numbers of the students' first birth and twentieth birth and midwives were entered on the vertical axis 1 to 45. The horizontal axis was arranged in individual columns highlighting the phase, the coded category and sub category with one column for each level of relevance. The assessment phase had a total of 37 columns prepared to enter the number of protocol segments from each data set. An example of a spreadsheet illustrating the number of coded data segments in the assessment phase, history category, sub categories and levels of relevance is listed in table 4.4 below.

Table 4.4: An excerpt from the Excel spreadsheet for the assessment history phase

Group	Ass. his. data 1	Ass. his. data 2	Ass. his. data3	Ass. ski. cue 1	Ass. his. cue 2	Ass. his. cue 3	Ass. his. b'line 1	Ass. his. b'line 2	Ass. his. b'line 3	Ass. his. clar 1	Ass. his. clar. 2	Ass. his. clar 3
1		1				3			3			
2			1		2	1		1				1
3					1	2			1			1
4						2	1		1			2
5			3			6			1			
6		1	3		1	4		1	1			
7		1			4	3		1	1			
8		1	1		2	4					1	
9			1		1	3						1
10 ↑ ↓ 45		2	2			6			3			1

The delivery, after birth and reflection phases followed the same procedure described above and the relevant coded verbal protocol segments were individually entered. The numbers were collated and subsequently imported into a computer software package for the analysis (SPSSX, 2009).

The analysis of data was based on a combination of qualitative and quantitative techniques. The quantitative analysis is a series of Wilcoxon Signed Ranks Tests on the data set of students (after their first and twentieth birth) and a series of Mann-Whitney Tests on the data set students (after their twentieth birth) and experienced midwife” (Bland, 2000; Burns, 1994; Clegg, 1992; McMillan and Schumacher, 2006). The importance of this approach was examining the knowledge growth and the clinical decision making of students performing their first and twentieth birth and comparing the students’ knowledge (after their twentieth birth) and decision making with those of experienced midwives. The qualitative analysis used a case study technique. Raw data from two typical representations of students (after their first and twentieth birth) and midwives, telling the story of performing the birth in the richness of their own words, illustrated the individual differences in the structure and growth of their knowledge.

The Quantitative Analysis

The quantitative analysis of the study was a series of Wilcoxon Signed Ranks Tests and a series of Mann-Whitney Tests that examined the differences between the quantity and quality of recalled declarative, procedural and conditional knowledge segments in the students (first and twentieth birth) and experienced midwives’ data. These measures add insight into the quality of knowledge the students and midwives used to make clinical

decisions. However the findings may not account for the way in which this knowledge is structured and made use of when reasoning clinical decisions. Therefore a further examination of students and midwives' data was conducted in a qualitative analysis to examine the structure of knowledge and how it is used when making clinical decisions.

The Qualitative Analysis

The qualitative analysis of the cases of two students and two midwives was conducted to gain a greater understanding of how students' knowledge develops and is structured as they grow from their first birth to their twentieth birth, and as the student's knowledge (after their twentieth birth) compares with the experienced midwives' knowledge. Two students (after their first and twentieth birth), together with two midwives were selected and were typical of the range of the students' group and midwives' group therefore selected as the representative cases for the analysis. These data are likely to facilitate an understanding of all students' and midwives' knowledge structures and yield rich information to explain their knowledge development and the clinical decision making of their experiences performing a normal birth.

Chapter Summary

This qualitative study with elements of quantitative analysis was selected to examine the knowledge growth and the clinical decision making of students and experienced midwives at a normal birth. The protocol analysis design used retrospective reports recalled by the students and experienced midwives in a structured interview schedule. The structured interview was based on the chronology of the birth, and these specific processes and procedures classified the reference points to identify the students and midwives' knowledge, skills and attitude within their data. The chronology of the birth described in four phases sequenced the subjects' recall of the task and guided the preparation of raw data (firstly audio tape recorded and later transcribed) into verbal protocol segments.

All verbal protocol segments were coded and mapped by a set of operational rules in three major categories. The categories of students' and midwives' knowledge / declarative knowledge, the skill / procedural knowledge and attitude / conditional knowledge data were quantified in degrees of relevance and appear in figure 4.2. The general midwifery competency standards, knowledge types and the study's coding scheme are used as the theoretical framework to operationalise students and

midwives' data in order to demonstrate the students' knowledge growth from their first to the twentieth birth compared with that of the experienced midwives.

In the next chapter the results of the quantitative and qualitative analyses are reported. The quantitative results are reported in the first section and the qualitative cases are analysed in the second section with a discussion of all the findings.

CHAPTER FIVE: THE RESULTS

The previous chapter outlined the study's design plan. The Chapter discussed all subjects' details followed by the design plan for data collection involving the construction of a structured interview and its relationship with the birth task. The remainder of the Chapter described the design of the protocol analysis, its coding scheme employed to categorise and quantify students' and midwives' verbal protocol segments, and finally the details of the quantitative and qualitative analyses selected.

Chapter five reports the results from the quantitative and qualitative analyses of students' and midwives' data in two sections. In the first section, the quantitative analysis examines students' (first and twentieth birth) and experienced midwives' verbal protocol data in order to identify the nature of differences between the knowledge they use when performing the task of a normal birth. The knowledge, skills and attitudes (the general competency standards for a midwife), and the declarative, procedural and conditional knowledge (theoretical types of knowledge) identified in chapter three, provided a basis for the analysis. These results are reported and discussed.

The second section reports the qualitative analysis of students' and midwives' data. The purpose of this analysis is to examine the development and structure of students' knowledge growth (part one) and the structure of experienced midwives' knowledge (part two). A descriptive narrative is the basis for the analysis and provides a story of the birth in the students' and midwives' own words. The analysis is reported in levels of understanding, a framework discussed in chapter three.

Section One - The Quantitative Analysis

This section reports the results of the analysis of verbal protocol data of students (first and twentieth birth) and midwives. The purpose of this analysis is to examine the type of knowledge students (after their first and twentieth birth) and midwives used and recalled when performing a normal birth and subsequently to answer the research questions:

- 1) What is the nature of the differences between midwifery students (after their first and twentieth birth) and experienced midwives in

their use of declarative, procedural and conditional knowledge when making clinical decisions during a normal birth?

- 2) What is the nature of midwifery students' discipline specific knowledge after their first and twentieth birth when making clinical practice decisions?
- 3) What is the nature of experienced midwives' discipline specific knowledge?

A series of Wilcoxon Signed Ranks Tests was conducted on the data set 'students first and twentieth birth' and a series of Mann-Whitney Tests on the data set 'students twentieth birth and experienced midwife' to assess:

- 1) the differences in the quantity of the students' (after their first and twentieth birth) and midwives' knowledge segments;
- 2) the differences in the relevance (quality) of the knowledge segments of the students (after their first and twentieth birth) and midwives' data; and
- 3) the differences between the quantity and quality of knowledge segments of students (after their first and twentieth birth) and midwives.

The computer software package PASW Statistics 17 program was used for data analyses (SPSSX, 2009).

Knowledge / Declarative Knowledge Category

The knowledge / declarative knowledge category represents the students' and midwives' knowledge of midwifery and its application when reasoning decisions. To explain this category an example from an experienced midwife's data preparing for the woman's birth is utilised. In this instance the midwife had identified '*...piece of her history that was (from) the last birth; she (woman) had an episiotomy that went to a 3rd degree tear*' (Doris) were data cues that added to the woman's history. The effective interpretation of a woman's history relies on the midwife's ability to link data cues with prior knowledge in order to plan and make the necessary decisions for her care. The category has four sub categories: history data, history cues, history baseline and history clarifies, which were developed specifically to capture all data related to students' and midwives' knowledge; and subsequently combined to form the knowledge / declarative knowledge category.

In order to examine the use of prior declarative knowledge by students and midwives when making care decisions:

- (a) a series of the Wilcoxon Signed Ranks Test was conducted with student midwives' data (after their first and twentieth birth) to examine their recall of no relevance, some relevance and high relevance knowledge / declarative knowledge segments;
- (b) a series of Mann-Whitney Tests were conducted on students (after their twentieth birth) and experienced midwives' data to test their recall of no relevance, some relevance and high relevance knowledge / declarative knowledge segments.

The Wilcoxon Signed Rank Test shows that the observed differences between the recall of the student midwives (after their first and twentieth birth) of no relevance and some relevance knowledge / declarative knowledge segments were not significant, but the observed difference between the student midwives' (average rank of 2.00 versus average rank of 8.43) recall of high relevance knowledge / declarative knowledge segments was significant, $Z = 3.30$, $p = .001$. The students after their twentieth birth recalled significantly more highly relevant declarative knowledge than students after their first birth. The medians and range of knowledge / declarative knowledge segments are presented in table 5.1

Table 5.1: median and range of knowledge / declarative knowledge category in the assessment phase, in levels of relevance in the student midwives (first and twentieth birth)

Student first birth N = 15		Student twentieth birth N = 15	
<i>Median</i>	<i>Range</i>	<i>Median</i>	<i>Range</i>
nr 1.0	0–8.0	nr 0	0 -3.00
sr 11.0	3.0–18.0	sr 9.0	3.0-17.0
hr 16.0	8.0-28.0	hr 23.0	14.0-50.0

The Mann-Whitney Tests showed the observed differences between students (after their twentieth birth) and experienced midwives in their recall of no relevance, some relevance and high relevance knowledge/declarative knowledge segments were not significant.

Skills / Procedural Knowledge Category

The skills / procedural knowledge category captures the skills required by a midwife when performing at the birth during the assessment, delivery and afterbirth phases. The following example illustrates this knowledge category '*because the baby didn't cry*

immediately, and '...was a bit worried... so I clamped (and cut) the (baby's) cord' (Dora, after her twentieth birth) and the baby was then given to another team member.

The student had acted on the data cues, anticipating the baby may need resuscitation. Situations can change suddenly during birth and seconds count. To anticipate cues and act accordingly require declarative knowledge combined with procedural knowledge to make the necessary care decisions. This category has three sub categories (action verbal, action non-verbal, action process and procedures) but was subsequently combined to form the skills / procedural knowledge category for the purpose of analysis.

To examine the use of prior procedural knowledge students and midwives apply when making care decisions:

- (c) a series of Wilcoxon Signed Ranks Test was conducted on student midwives' data (after their first and twentieth birth) recall of no relevance, some relevance and high relevance skills / procedural knowledge segments;
- (d) a series of the Mann-Whitney Test was conducted on students (after their twentieth birth) and experienced midwives' data recall of no relevance, some relevance and high relevance skills/procedural knowledge segments.

The Wilcoxon Signed Rank Test showed that the observed differences between student midwives (after their first and twentieth birth) in terms of their recall of no relevance skill/procedural knowledge segments was not significant, but the observed difference between the student midwives (average rank of 8.42 versus average rank of 2.00) and their recall of some relevance skill/procedural knowledge segments was significant, $Z = 3.05$, $p = .002$. The students after their first birth recalled significantly more some relevant procedural knowledge than students after their twentieth birth. The observed difference between the recall of the students (first and twentieth birth) (average rank of 1.00 versus average rank of 8.50) of high relevance skill/procedural knowledge segments was significant, $Z = 3.35$, $p = .001$. The students after their twentieth birth recalled significantly more highly relevant procedural knowledge than after their first birth. The medians and range for skill / procedural knowledge segments are presented in table 5.2

Table 5.2: median and range of skill / procedural knowledge category in the assessment, delivery and afterbirth phases, in levels of relevance in students (first and twentieth birth)

Student first birth N = 15		Student twentieth birth N = 15	
<i>Median</i>	<i>Range</i>	<i>Median</i>	<i>Range</i>
nr 1.0	0-9.0	nr 0.0	0-4.0
sr 10.0	2.0-23.0	sr 5.0	0-15.0
hr 12.0	4.0-24.0	hr 26.0	14.0-58.0

The Mann-Whitney Tests showed the observed differences between students (after their twentieth birth) and experienced midwives in terms of their recall of no relevance, some relevance and high relevance skill/procedural knowledge segments were not significant.

Attitude / Conditional Knowledge Category

The attitude / conditional knowledge category represents all groups' data as they rationalised their thoughts and actions when performing at the birth during the assessment, delivery and afterbirth phases. To illustrate the attitude / conditional knowledge the midwife recalled her reasoning. In this case the baby was born very quickly and '*...he (the baby) was tied up in his cord...the cord was actually quite reasonably tight around his neck...I didn't do anything about that...I just waited for him to deliver*' (Kerri). Kerri had determined no actions were required because she reasoned using her prior knowledge of labour and the woman's data cues. She made the decision to wait and the baby subsequently successfully delivered. Kerri, an experienced midwife, had used conditional knowledge to reason this decision. The normal birth of a baby is a complex process and the depth of a midwife's discipline specific conditional knowledge relates to the safety of the woman and the safe delivery of her baby. This category has three sub categories with one divided into two (rationalise action (certain or unsure), rationalise outcome and rationalise confirmation) but was subsequently combined to form the skills / procedural knowledge category for the purpose of analysis.

In order to examine the students' and midwives' use of prior conditional knowledge when making care decisions:

- (e) a series of the Wilcoxon Signed Ranks Test was conducted on student midwives' data (after their first and twentieth birth) to test student midwives' recall of no relevance, some relevance and high relevance attitude / conditional knowledge segments;

- (f) a series of the Mann-Whitney Test was conducted on students (after their twentieth birth) and experienced midwives' data to test their recall of no relevance, some relevance and high relevance attitude/conditional knowledge segments.

The Wilcoxon Signed Rank Test showed that the observed differences between student midwives (after their first and twentieth birth) (5.89 versus average mean rank 2.00) recall of no relevance attitude/conditional knowledge segments was significant, $Z = 2.63$, $p = .01$. The students after their first birth recalled significantly more no relevant conditional knowledge than after their twentieth birth. The observed difference between student midwives' (average rank of 8.18 versus average rank of 5.00) recall of some relevance attitude/conditional knowledge segments was significant, $Z = 2.36$, $p = .02$. The students after their first birth recalled significantly more some relevant conditional knowledge than after their twentieth birth. The observed difference between students (first and twentieth birth) (average rank of 4.00 versus average rank of 8.45) recall of high relevance attitude/conditional knowledge segments was significant, $Z = 2.54$, $p = .01$. The students after their twentieth birth recalled significantly more highly relevant conditional knowledge than after their first birth. The medians and range for attitude/conditional knowledge segments are presented in table 5.3.

Table 5.3: medians and range for attitude / conditional knowledge category in the assessment, delivery, and afterbirth phases, in levels of relevance in students (first and twentieth birth)

Student first birth N = 15		Student twentieth birth N = 15	
<i>Median</i>	<i>Range</i>	<i>Median</i>	<i>Range</i>
nr 1.0	0-9.0	nr 0	0-3.0
sr 10.0	4.0-20.0	sr 6.00	1.0-14.0
hr 10.0	5.0-30.0	hr 21.0	7.0-43.0

The Mann-Whitney Test showed the observed differences between the students' (after their twentieth birth) and experienced midwives' recall of no relevance, some relevance and high relevance attitude / conditional knowledge segments was not significant.

The knowledge segments in the assessment, delivery and afterbirth phases were examined in knowledge / declarative knowledge, skills / procedural knowledge and attitudes / conditional knowledge categories and the fourth phase of reflection results are examined next.

The Reflection Phase

The reflection phase represents all groups' data as they reflected on their thinking and actions in terms of the overall outcome of the birth. To explain this phase the example of a student's recall of her first and twentieth birth is illustrated and as a student (first birth) reflects '*...I don't know, that I had an actual (birth) plan as such...it just kinder flowed and went along*' (Lorraine) and her words highlighted minimal engagement in the complexities of the birth task. To illustrate the intermediate level of knowledge Lorraine rationalised her decision making during the twentieth delivery and explained her actions '*...we thought that she was ready to push and ready to have the baby. I examined her and she wasn't actually fully dilated yet, so we then had to change the plan and repositioned her...waited for the rest of that cervix to go...then she did push*'. This example of the student's development from student first to their twentieth birth showed her knowledge of the task had increased by the twentieth birth. All groups' data, coded in the reflection phase form the analysis.

In order to examine any differences in the quality of the reflections of students and midwives on the outcome of the birth

- (g) a series of the Wilcoxon Signed Ranks Test was conducted on student midwives' data (after their first and twentieth birth) in terms of their recall of no relevance, some relevance and high relevance attitude/conditional knowledge segments;
- (h) a series of the Mann-Whitney Test was conducted on students (after their twentieth birth) and experienced midwives' data in terms of their recall of no relevance, some relevance and high relevance attitude / conditional knowledge segments.

The Wilcoxon Signed Rank Test shows that the observed differences between the student midwives' (first and twentieth birth) (6.30 versus average mean rank 3.00) recall of no relevance in the knowledge segments of the reflection phase was significant, $Z = 2.70$, $p = .01$. The students after their first birth recalled significantly more no relevant knowledge segments in the reflection than after their twentieth birth. The observed difference between the students' (first and twentieth birth) recall of some relevance of knowledge segments of the reflection phase was not significant but the observed difference between students (average rank of 4.33 versus average rank of 8.36) recall of high relevance in the knowledge segments of the reflection phase was significant, $Z = 2.49$, $p = .01$. The students after their twentieth birth recalled significantly more highly relevant knowledge segments in the reflection than after their first birth. The medians and range for

attitude/conditional knowledge segments in the reflection phase are presented in table 5.4.

Table 5.4: medians and range for attitude / conditional knowledge category in the reflection phase, in levels of relevance in students (first and twentieth birth)

Students first birth N = 15		Students twentieth birth N = 15	
<i>Median</i>	<i>Range</i>	<i>Median</i>	<i>Range</i>
nr 1.0	0-12.0	nr 0	0-1.0
sr 8.0	2.0-22.0	sr 4.0	1.0-28.0
hr 2.0	0-8.0	hr 4.0	1.0-16.0

The Mann-Whitney Tests showed the observed differences between student midwives (twentieth birth) and experienced midwives in terms of their recall of no relevance, some relevance and high relevance the in knowledge segments of the reflection phase were not significant.

Discussion

The quantitative analysis examined the declarative, procedural and conditional knowledge employed when making care decisions by the students and the experienced midwives. The first analysis examined group differences (students first and twentieth birth) and (students twentieth birth and midwives) in the quality (no relevance, some relevance and high relevance) of their knowledge/declarative knowledge segments recalled after performing the clinical task. The second analysis examined group differences (students first and twentieth birth) and (students twentieth birth and midwives) in the quality of their (no relevance, some relevance and high relevance) skill / procedural knowledge segments recalled after performing the clinical task. The third analysis examined group differences (students first and twentieth birth) and (students twentieth birth and midwives) in the quality of their (no relevance, some relevance and high relevance) attitude / conditional knowledge segments recalled performing the clinical task.

The final analysis examined group differences (students first and twentieth birth) and (students twentieth birth and midwives) in the quality of their (no relevance, some relevance and high relevance) task as they reflected on their decision making recalled performing the clinical task. Overall the results indicated that experienced midwives and

students' (twentieth birth) prior knowledge appeared to be more highly structured and more readily accessible compared to that of the students (first birth). Both the midwives and the students' (twentieth birth) verbal protocols contained a greater number of high relevance knowledge segments in all three categories of knowledge types.

The results shown by the students (twentieth birth) and midwives suggest that their procedural knowledge related to the complexities of the task and expertise in birthing. This indicated a direct link between their declarative and procedural knowledge that enabled quick and more accurate identification of data cues, and understanding of the task relative to that of the students (first birth). The students (first birth) with little prior knowledge and experience of birth data cues, because of knowledge gaps and limited past practice experiences, resulted in minimal engagement in the complexities of the task.

The results of the students (first birth) recalled data in high relevance conditional knowledge are minimal. They did recall more some relevance and no relevance conditional knowledge than high relevance conditional knowledge, compared with the intermediate students. These results suggest there was a difference in thinking and knowledge development from the student's first birth to their twentieth birth. Students begin their practice with minimal discipline specific knowledge and develop their declarative and procedural knowledge during the course of learning and practice experiences and by their twentieth birth at the end of their program. The students at this level showed a similar level of relevance and quantity of conditional knowledge as that of midwives. However, from student to experienced midwife there are differences in thinking and the nature of these differences is in the individual's discipline specific knowledge base. Midwives results indicated the complexity of their conditional knowledge to reason and make care decisions.

The quantitative results painted a broad overview of students' and midwives' declarative, procedural and conditional knowledge used and recalled when making clinical decisions. This analysis only paints part of the picture because it does not reflect the individual differences in the development and structure of a student's knowledge from the first to the twentieth birth. A further examination of data looks at students' knowledge transformation in more detail and compares it with experienced midwives' knowledge. This follows in the next section.

Section Two: The Qualitative Analysis

The second section reports the case study's qualitative analysis. This analysis will examine the development of the knowledge growth of students by identifying the differences between the knowledge structures from students' first and twentieth births. The analysis will also examine the structure of experienced midwives' knowledge.

The boundaries of data analysis are the structured interview, in which students and midwives recalled what they were doing, thinking and saying during a normal birth. The hospital's delivery suite is the clinical setting where student midwives gain their experience and master the clinical skills of a normal birth, and is the site of the midwives' work role. The chronology of birth incorporates specific physical and psychological clusters of behaviour cues which are represented in four phases: the assessment, delivery, afterbirth and reflection. These provide a basis for this analysis (Yin, 1994). The character of every birth is unique. The students' and midwives' decision making are guided by a woman and based on their individual needs. These contextual circumstances could account for some differences within each student and midwife's data.

To examine the individual differences in the structure and growth of knowledge, two students (Amy and Kate) and two midwives (Jane and Claire) were selected as representative of the two groups (see Appendix 14). Within each individual's data, the richness of telling the story of the birth in their own words is represented in readable sections while still retaining the semantic intent. Two data sets from students (first and twentieth birth) and the midwife groups are manageable for analysis given the vast amount of data generated.

The analysis in this section is presented in two parts: part one is the analysis of students' interview data collected after their first and twentieth birth. The second part of the analysis reports on midwives data collected after performing a normal birth.

Part One

The Student Midwives – Setting the Scene

The student midwives' group (N=15) varied in their previous experience, including if they were previously a Registered Nurse at the commencement of their midwifery program. They had a range of four to 11 years (average 5.7 years) experience. During this experience they developed a nursing knowledge base, including the ability to reason and

make clinical decisions. Of the group, three students had an undergraduate Nursing Certificate, four a Diploma of Nursing and eight students had a Bachelor of Nursing degree. Novice students enter the Graduate Diploma of Midwifery with little formal midwifery knowledge.

Throughout the course of learning a broad range of assessments assisted in the development of students' repertoire of midwifery knowledge and skills. The program consists of a series of formal lectures linked with clinical practice; during which students are required to master 20 normal births. The students have a minimum of 26 weeks in a delivery suite to acquire the necessary practice skills. The mastery of the first birth is scheduled after students attend the regulated number of formal lectures and simulated classroom practice sessions, and have witnessed five normal births in the clinical setting. During their practicum, the student midwives are always supervised in the Hospital setting either by the Clinical Nurse Educator (CNE) or an experienced senior midwife (SM). The hospital's birthing practices require a minimum of two health professionals (not including a student) to be present at each birth.

The students' data, which they were asked to recall after performing their first and twentieth birth, were varied and two student midwives, Amy and Kate (pseudonyms), were the groups' representative cases. The numbers of all students' protocol segments, represented in levels of relevance during their first and twentieth delivery, are listed below in the table 5.5. The levels of relevance are illustrated by the abbreviation **nr** (no relevant data); **sr** (some relevant data); and **hr** (highly relevant data) for each student.

Table 5.5: the number of all students' protocol segments in levels of relevance

Student name	Protocol segments		
AMY	nr	sr	hr
First birth	22	60	35
Twentieth birth	9	30	83
LAURA			
First birth	0	31	35
Twentieth birth	1	14	57
EMILY			
First birth	17	19	38
Twentieth birth	1	5	60
CORAL			
First birth	11	61	51
Twentieth birth	2	42	60
LORRAINE			
First birth	3	24	29
Twentieth birth	0	23	64
KATHY			
First birth	7	32	31
Twentieth birth	0	23	64
MAGGIE			
First birth	10	30	37
Twentieth birth	5	18	70
JUDY			
First birth	17	61	34
Twentieth birth	6	27	78
SASHA			
First birth	4	22	49
Twentieth birth	0	21	79
KATE			
First birth	0	41	54
Twentieth birth	0	27	112
JOANNE			
First birth	18	46	45
Twentieth birth	0	55	103
MARIA			
First birth	11	39	37
Twentieth birth	2	35	118
DORA			
First birth	4	40	53
Twentieth birth	4	51	109
GLADYS			
First birth	1	27	63
Twentieth birth	0	22	81
VALERIE			
First birth	6	50	64
Twentieth birth	0	32	86

The mean and the standards deviations in levels of relevance of the students' first birth and the students' twentieth birth protocol segments are shown in table 5.6.

Table 5.6: the mean and standard deviations of students' protocol segments in levels of relevance

Group	Student first birth		Student twentieth birth	
	<i>Mean</i>	<i>S.D</i>	<i>Mean</i>	<i>S D</i>
All protocol	nr 8.73	6.88	nr 2.00	2.68
segments	sr 38.86	13.74	sr 28.33	12.86
	hr 43.66	10.97	hr 81.6	19.64

The individual scores by Amy (35 highly relevant knowledge segments for the first birth and 83 for her twentieth birth) and Kate (54 highly relevant knowledge segments for the first birth and 112 for her twentieth birth) are typical of the student groups' range of scores. These details demonstrate the average of all the student midwives' group and validate the choice of Amy and Kate as typical students in the group.

Levels of Understanding - the Students' First Birth

A typical novice student embarks on their clinical practice in a hospital setting with some theory and practice knowledge, however with little opportunity to integrate the two. They also often have difficulties distinguishing between relevant and irrelevant information when considering clinical data cues. Their practice therefore requires constant supervision and assistance.

The practicum provides the opportunity to forge the links between theory and practice knowledge and as a result the nature of their knowledge changes. As more and more links are forged between pieces of knowledge that share commonalities, categories begin to develop forming into distinct networks of knowledge. There are individual differences in development of their thinking and the nature of these differences is examined in the data.

Student Amy, the first case study, performed her first normal birth 15 weeks into the Diploma program and her twentieth by the end of the program. Prior to enrolling in the Diploma program Amy had eight years' nursing experience as a registered nurse in the health system and held a tertiary Diploma of Health Sciences (Nursing).

Student Kate, the second case study, performed her first normal birth 18 weeks into the program and the twentieth by the end of her program. Kate was a registered nurse with 15 years' nursing experience in the health system. When she enrolled in the Diploma program she held a hospital based nursing certificate.

Reporting of the two cases begins with data recalled during the interview after the first birth followed by the interview after the twentieth birth. The students' first and twentieth birth data will be compared to identify any changes between their thinking and actions at each level of expertise. The analysis reports the chronology of birth in the specific sequence of four birth phases (assessment, delivery, afterbirth and reflection). At the end of the birth students reflected upon their knowledge of the birth and their reasoning processes.

The Assessment Phase

The focus on a midwife's task in the assessment phase is to assess the woman's readiness to birth. The assessment is based on the woman's previous birth history and her progression through the first stage of labour. These data cues are then used to make decisions about preparing the setting, and the woman for birth (see appendix 8 for a full account of the midwifery care in the assessment phase). The quality of a student's knowledge of labour plays an important role in forming an accurate assessment.

Amy's Assessment

Amy explains her assessment below:

she was starting to bulge around the anus and getting very irritable, wanting to push, really wanting to push, we kept asking her to put it off as long as possible because there was...no sign of the head yet...you could see her coccyx actually moving out ... she couldn't stop herself from pushing and she just involuntary started pushing...she just sort of pulled herself up the bed and looked like she was getting herself ready...and because the head was starting to; you could see it was just off crowning.

In planning and preparing for the delivery Amy indicated the equipment she needed for both mother and baby:

... the neonatal resus equipment...//...warmed the clothes...got the heater going...checked that everything was working. Got the trolley ready...all the clamps and the cord...and manoeuvred her into a position.

Amy then clarified her thoughts for the delivery:

...it's like just thoughts coming in and out of your head. ...I was going over, deliver the anterior shoulder first and then the posterior shoulder and the movements and that I'd have to watch the restitution of the head ... I didn't think about the cord at all I forgot about that...also trying to focus on what was going on around me...thinking about what was happening and what position she was ...supposed to be coming out in. And just trying to listen to everything else that was going on and what I was supposed to be using on the trolley and where the clamp was and all that sort of stuff.

Amy experienced difficulty concentrating on the task. She expressed feeling that her thoughts were coming and going as she prepared for the birth. Her reasoning was limited to describing data cues observed, for example describing the signs of the woman's 'coccyx actually moving out' and her symptoms of being irritable and wanting to push. While Amy explained some procedural knowledge in her actions in preparing the neonatal equipment (if needed), and the clamps for the baby cord, she was making some links between data cues from her knowledge. Amy described the changes to the woman's body as the sight of the baby's head was moving through the final part of the birth canal. These minimal links suggest she was merely stating isolated facts of declarative knowledge. The assessment was fragmented and there was little evidence of what she was describing transferred into care decisions. It appeared learning and working in this new setting, the demands of the task and care of the woman and her baby, caused undue pressure for Amy. Her hesitation with task knowledge was reflected in a lack of confidence and gave the appearance of a detached observer, a characteristic of a novice (Benner, 1984). Her decision to prepare for the birth was made under the guidance of a Clinical Nurse Educator.

Kate's Assessment

Kate's assessment and woman's readiness to delivery are explained below:

We commenced the syntocinon...it was only turned up to 2 milligrams...she went into...first and quite quickly to second stages... she just wanted to push and that was our initial assessment. Like that was hard to assess it...the vaginal examination wasn't performed...//...I palpated the contractions ...that was about the only thing I did...she progressed right along...she was up on the bed and so we just looked at her with one of the contractions where she was involuntary pushing and looked at her vagina and could see that it was starting to stretch and pout.

Kate explained her assessment:

I decided...she was in transition because she became quite irritable towards her partner. They had a good relationship up until that stage, then he was doing everything wrong and...//...from reading my text and reflections that I've had that's transition...

The care plan for the birth was discussed with the woman:

I spoke to her as we were connecting the drip up as to what birth she wanted...we went through her birth options and she had wanted the birthing stool...but as we were progressing through...//...the labour came on so quickly she changed her mind and was quite happy to have the baby on the bed.

The birth options are discussed in the antenatal setting and it includes...what sort of delivery they want, do they want the lights on...music they want in the background...how they want to have their baby; on the bed, standing, on a birthing stool or whether they want to give their baby vitamin K...the cord cut and whether they want to hold the baby first...are the things that come up in the birth ...so we can have an idea and we can discuss it at the beginning of the labour.

Kate explained the equipment required:

...as I was making my own assessment. I discussed those with her and she (midwife) was basically my guide and...with what I have learnt...I set up the delivery trolley...checked the resus equipment on the neonatal trolley and ensured I had all the right equipment...I counted of all my equipment and had my protective gowning on for the universal body precautions. And I usually wear my glasses.

Kate's thoughts while preparing for the delivery:

I was only thinking about the delivery itself...how I'd approach it...when to put my hands on, just reflecting upon the births I had already seen performed by other midwives and what I read and collating that and trying to work out how it would fit in to this situation...you see other midwives doing things and they are conflicting sometimes.

So you have to make your judgment so I was...going through the mechanisms of labour in my head so I knew how the baby was coming out. So basically what I'd learnt was to hold onto the head lift the anterior shoulder up bring the anterior down then bring the posterior up.

Kate's actions and thinking are characteristic of this level. Kate linked data cues (for example, the woman's involuntary pushing and external view of the vagina starting to stretch and pout) to her declarative knowledge in recognising the progression of the baby's head through the birth canal. Kate was able to predict her actions (procedural knowledge) as the cues unfolded and used her declarative knowledge to make decisions in planning for the birth. Kate explained how she linked her knowledge with data cues recognising the woman's level of readiness to deliver her baby saying that *after '...reading my text and reflections that I've had; that's transition' stage of labour the interval between 8 to 10 centimetres dilation of woman's cervix*'. On the occasions when she was unsure Kate did request confirmation of her knowledge or decisions related to her planning with the experienced midwife in charge.

Amy's and Kate's dialogue illustrate differences in knowledge and practice levels during the assessment phase of their first normal birth. Amy was unsure and had difficulty linking her theory and practice knowledge with data cues to reason her decisions. Her constant reliance on another person to guide her actions as opposed to any independent actions is consistent with the level of performing her first birth. For Amy her limited knowledge and experience of a normal birth were apparent. She was apprehensive in her assessment, unsure of what to do or say and dependent on others for assistance and direction. On the other hand, Kate's beginning knowledge was evident by the links she made with data cues and practice in order to make her planning decisions. A feature of her planning was the ability to organise and prioritise the tasks, as she set up the delivery equipment trolley and also described the type of universal precautions – protective gowning and wearing glasses – procedures she would take.

The Delivery Phase

The *delivery phase* is classified as the second stage of labour (described in chapter four). The task requires a midwife to recognise cues from the woman and act accordingly (see appendix 8 for a full account of the midwifery care in the delivery phase). Throughout the birth of the baby the situation can change suddenly and requires a knowledgeable, skilled midwife to anticipate and make accurate care decisions quickly. Actions (procedural knowledge) are the primary focus in this phase. Knowledge of the delivery phase involves the mechanism of labour (declarative knowledge) and the skills (procedural knowledge) assisting women to birth by being prepared for possible changes in partnership with the woman in her care.

Amy's Delivery Phase

Amy clarified what she was doing during the delivery phase:

I put a bit of...pressure on the head because she was pushing a bit hard and the perineum wasn't stretching very well...I was supporting her leg on my side. Mostly putting pressure on the head until it crowned and then we got her to give it another push, little push and pulled the peri over the face...then Vera gave her face a good wipe and then we checked the cord...pulled the cord over the head, which was nice and loose. And she had to move again so we [could] actually manoeuvre the anterior shoulder out ... and the posterior shoulder came...[with] no tears [to the perineum].

Amy reflected on her thoughts:

I remember thinking this feels...sort of like slow motion and time was standing still. And you're trying to listen to what people are saying...I remember trying to make myself concentrate on what I was supposed to be doing, but it was just amazement mostly, it's not like you're really thinking about. And I

remember just straight after the delivery I said oh a lot of blood and the baby was really white.

I was just sort of concentrating on her delivering and you hear all the noise going on but you don't necessarily take it in...I do remember at one stage thinking oh my God what am I doing here? It's pretty amazing.

Amy's communications with the woman and the team are explained:

I didn't say a lot because...Vera and another student midwife from the group before us and another midwife were in there helping her along. She was pushing too hard and she was having trouble focusing and listening...I think at one stage I said, now, you know come on breathe, breathe, calm down. But I didn't say a lot to her, most of the instructions came from Vera and the other midwife, I was just dumbfounded...I was just listening and doing what I was told.

Amy described her actions that related to what she was seeing rather than integrating data cues to her declarative and procedural knowledge. The delivery was clearly under the guidance of the CNE. In the example of delivering the baby's head, Amy did not identify the association of the internal rotation of the baby's head as it turned and rotated under the symphysis pubis. The narrative of her actions and uncertain communications with the woman were recalled as isolated facts. She was unsure and found it difficult to concentrate, her affective feelings of disconnection with the procedure showed a lack confidence with her actions.

Kate's Delivery

Kate demonstrated her procedural knowledge as illustrated by the example below:

I basically let the lady deliver by herself. I stood on her right hand side...and I let the head birth itself and I applied gentle pressure to the top of the head as it was moving and guarding the perineum and as the head birthed then I checked for the cord and I let the baby reposition itself. I didn't touch because I knew it was going into restitution and as the anterior shoulder came down I helped bring the posterior shoulder out and on onto the mum's chest.

Kate's reflected on her thoughts:

...one of my main concerns were the complications...what would I do if the cord was stuck around the head which it was and I was able to quietly pull over the baby's head. I watched the baby on the perineum I didn't want the mother to have a tear [to the perineum]. I was mainly thinking of what would I do if there were more complications...and then just thinking about the 3rd stage. Once the baby was born I was watching the blood loss mainly.

Kate was able to communicate with the woman:

I encouraged her...told her when the head was born so she could look down and see the baby's head and just explained to her that I was just putting my finger into her vagina [to] feel for the cord and that if she felt anything that's what it would be...told her while I was checking for cord not to push. I did want to make sure the cord was not there and I encouraged her not to push.

Kate described the delivery of the baby with more confidence than Amy. Kate was able to identify her actions clearly during this first delivery. The data cues were linked with her beginning knowledge to deliver the baby confidently with an accurate description of the process.

Amy and Kate differed in the use of their knowledge during the delivery phase. Amy was hesitant in the use of her knowledge and skills and required assistance and supervision throughout this delivery. The anxiety associated with her uncertainty took up space leaving less for the task. On the other hand, Kate was able to accurately describe relevant and accurate features of the task. Her explanation of the delivery indicates her knowledge shows the beginnings of her networked declarative knowledge of the baby, the woman, and her personal and practice (procedural) knowledge, and the birth setting itself. For example, Kate referred to the delivery of the baby's head in the first paragraph above and the position of the cord during the delivery in the third paragraph above. These examples demonstrate the development of her conditional knowledge.

The Afterbirth Phase

The *afterbirth phase* signifies the third stage of labour which is the expulsion of the placenta. This phase requires students to link data cues from women with their prior knowledge and skill to safely deliver the placenta (see appendix 8 for a full account of midwifery care in the afterbirth phase). The main focus of concern in the afterbirth phase is delivery of the placenta which requires declarative and procedural knowledge to monitor the woman and her baby for sudden changes. This third stage is more complex and requires conditional knowledge because the midwife is planning and monitoring care for both the woman and her baby.

Amy's Afterbirth

Amy accounted for her actions during the delivery of the placenta below;

*...the baby was put onto her stomach initially, stimulated a little bit and then Kay the other student midwife and Anne took the baby over to the resus area and worked on it a little bit because she was a little bit flat and not very responsive.
I stayed with Vera and the woman and she'd already had the syntocinon so we delivered the placenta...did a bit of fundal massage and got that down.
By this stage the baby pinked up a bit and was breathing that much better.
I basically stayed with the woman and delivered her placenta with Vera and estimated blood loss and everything... the other midwives did all the neonatal resuscitation and then I did the neonatal checks and gave the vitamin K.*

Amy described her thoughts at the time;

...I was pretty amazed...was trying to concentrate, I could hear them working on the baby in the background and I was trying to concentrate on the delivery of the placenta and listening to Vera...now the placenta's coming, and that came out really easily. And in between delivering that we were trying to look over at the baby for apgar scores and just get a feedback off them...mainly I was with the woman and just trying to make sure I was doing the placenta and the fundal massage correctly and just trying to take in the information that was coming back about the baby.

Amy's communication with the woman was minimal and

Vera talked to her mostly. I was following instructions, I did say to her, tell me if it hurts too much or I'm applying too much pressure. But she was I think...stunned just lying there and just nodding. And at one stage as the placenta was coming out she said what's happening...Vera and I said together we're just delivering your afterbirth.

The delivery of the placenta was under instruction from the CNE who interpreted the woman's data cues and instructed Amy in the correct procedure. The connections were made for Amy because she was unable to link data cues with her prior knowledge, contributing to her lack of certainty, which led to difficulties in concentration.

Kate's Afterbirth

Kate accounted for her actions during the delivery of the placenta below:

...after the delivery...I had the second midwife...she dried and warmed the baby...it was sitting on its mother chest while I was delivering the placenta. At the same time we explained...to the mother...I was going to deliver the placenta. I basically talked to her and congratulated her and was happy about the fact she had her baby.

*I was monitoring the woman's blood loss...I didn't actually initially do anything for the baby because the second person at the delivery was in charge of the baby...reassured the mother and explained to her...the delivery of the placenta and explained what I had to do with the placenta.
It was all very exciting for me!*

Kate's thoughts during this time:

...my concern was her blood loss. I wanted to make sure that she wasn't loosing a great deal of blood. I suppose I was a bit concerned about the placenta, I felt it wasn't coming out quick enough but it was...it came out within 11 minutes.

It wasn't a long time but because I was standing there waiting...having things going through you've read about retained placentas and blood loss and things like that. I was concerned and I kept saying to the midwife...how are we going what should I do now, is the cord lengthening, I was nervous with pulling on the cord and giving some...mild traction...because to pull too hard could detach the cord...and we put the baby on the breast...it was a long time standing there to wait for the placenta to be born.

Kate communicated with the woman:

...talked about a name of the baby; had she thought of any names, how exciting it was that was she had a little boy. I had built up a rapport with her...and we were talking about how the family would be excited. And after the birth I just told her this was my first birth...and she was very pleased that she could be my first.

In this case Kate was able to demonstrate and explain her prior knowledge of placental separation and the possible complications associated with the process. Kate explained the normal process and the possibility of a deviation from the norm and her account demonstrated the use of declarative and procedural knowledge with some conditional knowledge development. Kate was focused on what she was doing, looking for signs of separation and she became anxious about the length of time it was taking. The Senior Midwife assessed the problem and her solution was that the baby goes to the breast. A baby suckling on the breast releases a hormone that encourages the uterus to contract, assisting delivery of the placenta and a decrease in blood loss. Kate had pieced together some facts and anticipated delivery of the placenta. However she had not connected knowledge of the baby suckling and uterine contractions to data cues she observed. Her ability was consistent with her experience.

The knowledge required to manage the afterbirth phase is complex. Amy needed to be guided through the task with constant instructions by CNE. Her limited prior knowledge and anxiety gave grounds for consistent supervision and perhaps contributed to her lack of certainty and difficulties in concentration. Kate on the other hand, had a better understanding of the task and demonstrated more relevant knowledge of the correct processes in the task. Although she was not always able to accurately link data cues with advanced knowledge concepts, she was able to manage the mother and parts of the task.

The Reflection Phase

The *reflection phase*, while not a stage of labour, presents an opportunity for students and midwives to reflect on their thinking and actions with the overall birth process.

Amy's Reflections

Amy reflected on her thinking and feelings:

...when it [the baby] was born and we'd just got the cord over her head...you could see she was starting to try and breathe up and it didn't change much,

we sort of rushed her into a bit of a different position to try and deliver the shoulders and get her out.

I don't think it changed my plan; it all just scared me...she did come out quite white...before the shoulders were born she started trying to breathe up. At that stage she was pretty distressed.

Amy discussed her reflections of the process:

I don't know, it's still so overwhelming and a real blur because...//...you're still trying to put bits and pieces together as to what was related to what ... in the actual delivery itself.

It's gone through my mind so many times...I think about when she [the baby] tried to breathe up...it just scared me a bit...and the next feeling you thought was the head is out well the shoulders better come pretty quickly. And I remember looking at Verna and thinking she looked quite calm, it can't be too bad. And it did deliver quite quickly after that so there never was time to dwell on the fact that she was breathing up. And she did pass meconium straight after she was born, but she was definitely out by then.

It seemed so really chaotic to me, like you know out of control, but I suppose I haven't been in that environment so I'm not sort of used to listening to things. Everyone around me seemed very calm...it just seemed like a real blur...it's something I'll have to get used to...the quickness of it too...it's that high stress.

Amy's reflections focussed on many aspects of the birth not relevant to the process. These unrelated concepts highlighted her anxiety (Cantwell, 2004). Amy's judgment was limited to some isolated items of declarative and procedural knowledge. Amy explained what she was seeing but could not process these pieces of information. A different position was suggested for woman to assist in the delivery of the baby's shoulders. Amy's thoughts however were about the baby showing signs of breathing. It appears that while Amy was concerned others were not. This was reinforcing her limited prior knowledge on the relevant aspects of the mechanisms of delivery and its effects on the baby. Amy's thoughts and interpretation of her actions were observed and the birth was subsequently facilitated by another. Benner, (1984) described this behaviour is characteristic of a novice.

In this instance Amy reflected on the experience performing her first birth and established that it was stressful causing her to detach from the task and not be able to direct the process, leaving her with a sense of the unreal (Benner, 1984). This new discipline and unfamiliar setting proved stressful for Amy.

Kate's Reflections

Kate reflected on her thinking and feelings reviewing the birth plan and explained:

we didn't expect her to go so quickly...//...she only had...an hour for her first stage and we sort of discussed the plan that stopped because we didn't have the birth stool in the room...I think it came on so quickly she got a bit distressed herself. It did change the original options...the baby wanted to be born.

Kate discussed her reflections of the process including:

...I should have become familiar with the documentation...having to consult my senior midwife. I think I will be fairly nervous for a long time yet when I am delivering babies...probably just getting used to deliver the placenta and understanding that things can happen. I didn't expect it to go along so quickly and have such a quick delivery.

I feel ...she probably would have delivered even if I wasn't there...and didn't have any general trauma...she did have the syntocinon put up when she was already having contractions all over the place. So she was obviously getting close to first stage. This was a relatively easy birth and I hope they are all like that, somehow I don't think so.

Kate explained she would be fairly nervous delivering babies for a long while yet. With some concerns experienced, she remained realistic and demonstrated insight into her learning and practice of her developing decision making.

Amy's Knowledge and Reasoning

Amy explained her beginning knowledge:

...before it happened I'd been going over it in my head...mostly about the shoulders and how it would come out and [restitution of the head] and the crowning... I had Vera who was standing there giving me ongoing do this do that; little instructions, no pressure on the peri [perineum] just on the head. I think at one stage I did, before the shoulders were born, I did say to her now I pull down to the anterior and up...and she just sort of confirmed that...I'd thought about it before but also I was getting some instructions as I went.

The second stage of labour is a continual process and was the contributing factor in Amy's ability to perform her first birth. Amy's prior declarative knowledge of labour is a list-like understanding noticeable in her explanation above. She was beginning to link common pieces of information together about the delivery of the baby's head in a simple manner and she captured some important aspects of the process. Her decision making accentuated a weak knowledge association, for example the delivery of the baby's head is by internal rotation of the head and as it turns is directed under the pelvic arch and crowns; restitution, after the head delivers it turns to undo the twist in the neck that took place during crowning and then the shoulders are actively delivered.

Kate's Knowledge and Reasoning

Kate explained her knowledge below:

...we've had some in depth lectures on it and...from watching previous midwives. I have witnessed good midwives that actually explain as they go...I tend to use more of a visual scheme as a remembering [but] instead of actually reading it that's how I think I knew. And also as I went along I asked my senior midwife...I'd say something to her about what I was preparing to do or going to do, was this correct...and she gave me directions...we had this in the exam...the combination of what I've learnt and what I've seen.

Kate was able to explain the development of her practice as a combination of formal learning and observing experienced midwives in practice. Kate's knowledge structure was developing and transforming because she was able to assimilate her new knowledge and skills with prior knowledge in a network of common elements of the birth processes.

Discussion – Levels of Understanding after the Students' First Birth

The students' level of understanding was identified in the first of their 20 normal births that they are required to master in the Diploma of Midwifery program. At this point the students' prior knowledge and experience consist of facts from formal lectures, simulated birth experience in classroom practice sessions and observation of five normal births. This range of prior knowledge of the birthing process and the physical and psychological behaviours of midwifery care, did orientate students to the practice setting.

Amy performed her first birth under close supervision and assistance from a CNE. Amy's hesitancy with the task reflected a lack of confidence that caused her to be a detached observer at the birth. This type of response is typical of the novice (Benner, 1984). With her limited prior knowledge, decision making was limited to a list like understanding of the birth task and this loosely structured knowledge base was reflected in her lack of confidence and reliance on guidance from the CNE.

A loosely structured knowledge base is typical of beginning practice in a number of disciplines, for example medical and nursing studies (Azzarello, 2003; Boshuizen and Schmidt, 1992, 2000; Bordage and Lemieux, 1991; Patel and Groen, 1986; Patel et al., 1988). Novices, whilst able to draw on basic information associated with the task, demonstrate limited knowledge and ability to hypothesise when reasoning a task (Tanner et al., 1987; Westfall et al., 1986).

The development of declarative knowledge structures was beginning and Amy's limited prior knowledge caused her to rely on retelling her knowledge of the birth task in a list like manner, which demonstrated some knowledge transformation. Her developing procedural knowledge required scaffolding by the CNE. Under these circumstances Amy's thinking demonstrated minimal knowledge development at the multi-structural level of understanding (Biggs and Collis, 1989).

Kate was also under supervision and on occasions asked for assistance and direction from the SM. Kate anticipated and planned woman's care by linking data cues with her prior knowledge to make her decisions, demonstrating her developing discipline specific knowledge structure. The development of this birth knowledge provided her with the confidence to practice. Kate was beginning to form an understanding of some aspects of the birth process at a multi-structural level of understanding and with the beginnings of relational levels of understanding (Biggs and Collis, 1989). Kate's knowledge development was transitional.

Amy's and Kate's case analyses highlighted the differences in their levels of understanding. Both are mature age students with many years' experience as Registered Nurses prior to commencing the midwifery program. Each met the requirements to perform the first birth task yet they differed in their understanding. The birth context could account for some of the variations between Amy and Kate. The variation in their knowledge development was evident. Kate had developed her prior knowledge and with this knowledge she was able to recognise data cues and make her decisions at a here first birth, whereas Amy relied on retelling information with minimal evidence of knowledge transformation.

Amy and Kate are typical of the range of students (first birth) in the group. While some students have begun to integrate their prior knowledge with practice knowledge, others like Amy are in the process of making some connections.

Changes in the structure of knowledge between students' first and their twentieth birth are examined next. Amy and Kate, who are nearing the end of their Diploma program, were interviewed after performing their twentieth birth.

Levels of Understanding - the Students' Twentieth Birth

Amy and Kate performed their twentieth birth near the end of the program and data will demonstrate the difference between their knowledge developments from their first to their twentieth birth. Now at the end of the program we would expect the students' prior knowledge structures would have developed into categories of woman, her baby, and students' practice, and the birth setting through the integration of knowledge and practice experiences. These networked knowledge categories inform students' understanding of the normal birth as a whole, rather than separate categories of birth knowledge.

Results in this section are reported in the same format as Amy and Kate's first births.

Amy's Assessment

Amy explains her assessment:

I walked in to do the birth. I hadn't been with her [woman] in labour and her head was on view...it was nearly out, it came up really quickly. I was told that she was hepatitis C positive so I had to get all covered... and protecting the eyes with goggles. I didn't actually have a mask on because we didn't have time. She was a 33 weeker and [the baby] was coming out pretty quickly...Rachel who was there with me knew the lady well and setting everything up around me while I was basically waiting for the head to deliver.

She hadn't quite hit crowning...and her screaming...its coming...I could see it [head] just sitting there.

Amy explained:

...I walked in so late on it...apart from hepatitis C knowing I had to glove and gown quickly and knowing that this was a 33 weeker that I would probably be clamping and cutting the cord very quickly...I didn't plan...it happened so quickly. It wasn't actually what I envisaged for my last one.

Amy prepared the delivery:

...I double gloved and gowned. I listened to everything that Rachel was telling me. She would come over occasionally and throw things out at me because she had looked after the woman for the whole labour. I got to the bedside and coached her through on when to pant and when to push. She wasn't initially responsive to what we had to say but luckily her support people were her mother and her aunt. She managed to listen, I just got the tray ready and made sure I had my forceps on hand...I don't think there was any meconium but Rachel put the suction there just in case.

Amy's thoughts throughout the preparation:

I was basically trying to go through the moves and what I'd do as soon as the head was out I still try to do that...and at the same time give her instructions on when to give a bit of a push and when not... setting out my trolley and making sure I had everything on hand and watching her at the same time.

Just trying to take myself through the steps, and make sure I check the cord and watch the head turn; be ready.

In the assessment and preparation for the delivery Amy displayed she was able to anticipate routine care by linking data cues with her prior declarative knowledge of the woman and her baby when reasoning. Her decision as to the woman's readiness to deliver was based on the progression in the initial stage of her labour, and together with her previous birth history, along with her current clinical situation. The complication of a premature baby in a labouring woman who was hepatitis C positive was a concern for Amy. However, she could identify the correct practice procedures, donning double gown and gloves for her protection. Amy was alerted to the fact that the baby was premature and may require resuscitation. Amy identified all these items in her assessment and because of a more sophisticated knowledge structure was more independent when compared to her experience of her first birth.

Kate's Assessment

Kate assessment is explained below:

I had only met the woman...an hour and a half prior to her delivery because we were quite full...at the time we'd done some observations on her...she was sitting on a reclining chair, using the nitrous oxide and she [woman] started...to feel some pressure in her bowel and that she really wanted to push. I suggested to her that we should probably change position being in the reclining chair it was difficult to make any form of assessment. So I discussed with her several birthing positions and she wanted to just hop on the bed with the bean bag. This was for support for her back...a multi, her second baby...grunting with her contractions and doing involuntary pushing...so we just let her go with that for a while.

Then I noticed that there sort of wasn't any progress so with the woman's consent I asked if I could do a vaginal examination. She was 8 centimetres dilated and she still hadn't ruptured her membranes. So, in consultation with the midwife we decided to rupture her membranes to see if things could move along but it was unsuccessful...we suggested re positioning...her on the birthing stool for...about, 20 minutes. While she was on the birthing stool I discussed with her the previous birth and she had forceps with an episiotomy...she still had problems with her episiotomy 2 years down the track. So we had a bit of a discussion about that and I put her onto her all fours position just to lessen perineal trauma. 30 minutes later she delivered. If we hadn't done the vaginal examination I would have assumed she was fully. She had vaginal pouting, anal pouting and she was doing the involuntary pushing with a really loud grunt with each contraction.

Kate described her plan of care by:

...the fact that she was a multi and knew she was ready to deliver. She was very pushy and from her physical assessment and along with fact that she sounded like she was going to deliver.

I discussed with her about the birthing and ...I had her on the birthing stool...until she told me that she had this perineal trauma and I said to her you should try on all fours. So I put her over the beanbag and her husband steadying her.

Kate prepared for the delivery:

...I set up immediately and checked the resus and it was an unfamiliar resuscitation trolley because I was at Hospital B. They had older equipment and I had to familiarise myself...I set up the trolley and spoke to her about syntocinon and had that all ready.

Kate's thoughts while preparing highlighted her main concerns, drawing upon a malfunction with the setting:

...is that I have my resuscitation equipment ready that's something really important. I've been caught out in the past. I've gone in to second someone else and the equipment hasn't been set up so I like to ensure that I've got oxygen, I've got suction and that I'd have everything ready for when I open my delivery pack that I have all the equipment that I need.

Now nearing the completion of her program Kate was reasonably independent within her practice experience and able to anticipate routine care. For example, Kate had demonstrated confidence within her professional practice and associated data cues to reason care decisions which she clearly articulated without hesitation and with little reference to the care team. Kate's level of understanding and experience had continued to develop her discipline specific knowledge, and she was able to make decisions independently. For example, Kate linked the woman's history from her previous birth to this current birth to think through a plan of care. Because the woman's request to use the birth stool was contraindicated, Kate was able to suggest an alternate position, which resulted in a positive outcome.

Resuscitation equipment is required to be readily accessible for an emergency situation. Kate had identified a malfunction with the equipment. She had associated a previous experience with the resuscitation equipment to the current situation which provided the trigger to her long term memory, demonstrating her networked knowledge category of the practice setting. This past experience highlighted her need to be more cautious during the preparation to birth.

In the assessment phase of their twentieth normal birth and the end of the midwifery program Amy and Kate were able to describe their decisions when preparing for the women's birth. There were differences in degrees of knowledge development, both were able to link data cues to their knowledge, to make the decision and reason the solution.

With this knowledge they provided evidence of the foundation of their developing discipline specific knowledge base.

Amy's Delivery

Amy explained her actions delivering the baby;

I was putting a little bit of pressure on the head I have found a lot of the midwives or some of them say hands off and some say put a little bit of pressure so basically go with that and Rachel was a pressure person.

She [woman] wasn't always panting breathing when we wanted her too. So I was putting a bit of pressure and watching the perineum. Then she delivered the head...I swept to make sure the chin was out and wiped the face of the baby. Checked for cord...with the next push, I think she actually started to push before the next contraction, I put downward pressure on the baby to deliver the anterior shoulder but it didn't quite come out. It was probably out enough but then I heard Rachel say go up, up, up watch that perineum. So I had to go the other way, I didn't think the anterior shoulder was out but obviously it was because it was fine. He [the baby] just sort of tumbled out and started screaming. He probably could have got 10 for his 5 minute one [the apgar score]...I clamped the cord straight away and got somebody to cut it and [the baby] went onto her chest because he was so good, instead of going first to see the paediatric [team].

Amy's thoughts during the delivery:

At one stage I was thinking it is noisy in here, because it was such a crowd. Just as I said before was the sequence of events trying to remember them and now this has happened; now this is going to happen; now I have to do this you know, this is the way it goes sort of thing. You know I'm sort of planning as I was thinking of what I was going to do next. Just what I had to do was going through my mind and because the hepatitis C thing kept popping up every now and then because Rachel kept reminding me every time I got something [body fluids] that might spurt.

Her communication with the woman is described:

Basically instructions when the head was crowning and actually being born...give a little push here, no stop, start panting, or just breath it through, breath it through...she wasn't always listening but she got the hang of it eventually...I just told her, the baby's head is delivered and the next one the baby will be delivered and just kept talking her through telling her what was happening. I don't I know how much instructions actually got through to her. I think they did because her mother and her aunt there were right at her ear.

At this stage Amy demonstrated some of her prior declarative and procedural knowledge by explaining to the woman what to do as the head was delivering. She identified the correct process, recognising data cues while explaining to the woman her actions. However there remained some uncertainty with her procedural knowledge. The reliance on prompts from CNE during delivery the baby's head rather than having confidence in

her knowledge of the process was apparent. For example, this shows in the instructions given for the delivery of the baby's shoulder. Amy, in this instance, continually required confirmation from the educator in the task procedure. Discipline knowledge development is transformed by experience and reasoning, however on a number of occasions Amy relied on her delivery knowledge to be reinforced by the CNE.

Kate's Delivery

Kate explained the delivery task below:

I was encouraging the woman because when pushing she lost control. She was upset, she didn't think the baby was going to come out and she was going to have to have another forceps delivery and mainly reassuring her she was doing it and that we were seeing progress and we were seeing the baby's head.

I told her it was important to listen to me when I told her to stop pushing and let her body take over and I did have to give her instructions and it was important that she listened to me. Encouraged her husband to interact, I set little delivery area up between her legs so I had the green drape there and had equipment because the head just started to come out we realised there was meconium, she hadn't lost any fluid or anything. It was quite thick meconium, so I had everything ready...because the suction didn't actually reach. I knew we would have to cut the cord and take the baby straight away and I had a cloth to wipe the baby's mouth and nose as it came out.

...once it started to come I actually supported the head and also the perineum. I have been taught by some midwives not to touch it but in this case I felt that I really needed to put support on there because the old episiotomy site [scar] was starting to thin out. So I held that for support. It was quite, quite, firm to what it usually is. Just encouraged the woman once the head out was up to about the eyebrows, to stop pushing and breathe it out, and she didn't cause any more perineal trauma.

Once the head was born I cleaned the nose and the mouth...the baby didn't inhale...I checked the cord. I told the woman that I was going to insert my finger in and check for cord and then just delivered the shoulders. Back the front because I was doing all this blind. I delivered the shoulders, and put the baby on the floor. Clamped the cord, offered Dad to cut the cord but he wasn't interested in it. The baby was taken away...the woman rolled over to lean against the beanbag and ready to deliver the placenta.

Kate explains her thinking during the delivery:

I was a little bit upset at the fact...they don't have on the wall suction and that was something that I realised as I was setting up. While I kept thinking well we haven't suctioned this baby. I was also concerned about the fact that we had an old episiotomy site...my main concerns were to try and get an intact perineum. Also knowing that we had to get the baby away to the suction because of the meconium, I was planning my actions by cutting the cord, and planning in advance of what I was going to do for the baby once it was born.

Communicating during the delivery is described by Kate:

I gave her encouragement...the baby's coming out and we are not going to have to get forceps, and that it was all her work, and she was doing really well. Then just once the head crowned and the head was born to breathe and to stop pushing and just listen to me. She [the mother] was quite calm by this stage.

Kate had used her conditional knowledge and explained her reasoning in a logical manner. She remained focused upon her previous concerns, especially regarding the resuscitation equipment, which would have had consequences had the baby aspirated.

As the primary care giver, Kate was able to overcome her anxiety in continuing care. She associated the woman's past history cues observed with her discipline knowledge and experience, and employed strategies to alter her original plan of care. This signifies the transformation of knowledge and skilled experience and the catalyst for sound reasoning into discipline specific knowledge (Cantwell, 2004; Benner, 1984).

The difference between Amy's and Kate's delivery practice was in their degree of certainty in the use of their knowledge. Amy's uncertain procedural knowledge indicated gaps in the integration of her task knowledge. Alternatively Kate was assured and her integrated knowledge was used to reason care and make decisions.

Amy's Afterbirth

Amy described her delivery of the placenta below:

For the baby, the midwife and I sort of stimulated it a bit. It was pink straight away and I clamped the cord and got one of the friends to cut it... wrapped the baby up and popped it on her chest and gave it to her for a little while until the paediatric [team] had a look at it. Rachel gave the syntocinon and I delivered the placenta. I was a little bit hassled. She had a graze which wasn't clotting very well so we put a pad in there to try and stem the flow just in case it needed stitching. We did a set of observations and she lay in bed until we were happy with the blood flow and she was fine. Her fundus was nice and tight ...gave her something to drink; she didn't want anything to eat, finally got her up to the shower and to have a wee.

The baby stayed with her for a little while ... then we finally explained we might have to get a doctor to suture. Cleaned up and made sure she was comfortable.

Amy describes her thinking during the delivery of the placenta:

After the birth, that's my last birth out of the way, that's what I was thinking. She was an Aboriginal girl. A lot of Aboriginal people have a lot of people in the room; whereas a lot of the Caucasians only want the partner, or one other

person...//...I actually enjoy afterwards just watching them all and they are really excited and talking and chatting.

I noted the membranes were a bit ragged but Rachel didn't think so. So that was her assessment...just cleaning up and I was thinking I have to be careful because I still get a bit lazy afterwards handling the placenta I knew I had to be careful and keep goggles on.

Communicating with the woman Amy explained:

...why we had the pad trying to stop the blood or trying to clot the graze and what the name of the baby was. Just general chit chat sort of questions. Just took her observations and explained they were OK and soon we will get her up and get her something to eat, and we will get her up for a shower soon, and then go to the ward. I spoke to her briefly about a few things and just explained you know that she had to make a list of people that could visit the baby in NICU [Neonatal Intensive Care Unit]...//...To make a list of people who are allowed to see the baby in NICU and I explained that because in NICU they won't let anybody in unless there are on the list. I think it is an emotional thing they don't want them seeing the babies without their permission or without them in attendance. I think it is also a safety thing because a lot of the time when they make that list up there's always somebody on it that's says they are not to come in at all. So often there are social problems in between the family. It is part of a policy.

Amy explained her care and noted the woman's blood flow from a graze, and therefore checked her observations and established they were stable. Amy clearly explained her findings. At the same time she observed that the premature baby was pink and breathing even though protocol dictated that the baby be assessed and observed in the NICU. Amy clarified the visiting practice protocol of the unit, displaying her knowledge of protocols to the satisfaction of the family and demonstrated her networked prior knowledge of the practice setting. Amy had linked her knowledge to the baby's condition with her developing discipline specific knowledge.

Kate's Afterbirth

Kate described her delivery of the placenta below:

...made the woman comfortable...took off the dirty gown, placed her in bed and made her warm and comfortable and wrapped the baby was already wrapped up and gave mum a chance to hold the baby. I tried to instigate the feeding...it wasn't at all interested, so I gave time for mum to cuddle and dad too. I did the maternal observations...and left them for about 20 minutes to let it sink in that they were parents again...I went back in and offered the woman some fluids and something to eat...I tried to initiate breastfeeding again and baby still wasn't interested so I bathed the baby and weighed and measured it and wrapped it up and did its temperature and it was 35.8 at this stage, so I told the mum that we'd take it down to the nursery and just put it under the heater to warm it up.

I took the baby around...while it was getting warmed I checked the mum's observations again, checked the fundus, checked the blood loss and then got her up for a shower.

Kate described her thinking during the delivery of the placenta:

I was thinking did I make the baby cold? ...the fact that bubby got cold so quickly and the woman's fundus [uterus] was very difficult to palpate she had quite tight abdominal muscles and it was probably 4 or 5 finger lengths below the umbilicus...really low and difficult to palpate. I thought that this isn't right that she wasn't bleeding, so I thought it had to be fairly contracted because she was not losing any blood and I eventually found it was quite down low.

Generally I like let things to happen and waited for her to say, oh there's something in my vagina and I've really got to push, is that okay? But I also tilted the uterus to see if there was any retraction of the cord...I suppose just thinking I hate third stage. I tried a bit of gentle cord traction whilst we were waiting...it was going through my head what one of my educators told me about delivering third stage and making sure I'd covered those areas.

Kate's communication with the woman explained:

...to her what was happening to the baby, explained to her about the resuscitation trolley...she could see they were suctioning the baby and giving it a bit of a blow with the oxygen. I explained the baby had done a poo and that we just wanted to make sure that it was ok...and then explained to her about what we were waiting for. She asked me if she'd any [perineal] tears and so while I was waiting for them I had a little bit of a look and she hadn't had any perineal trauma that we could see. I explained...after the placenta I'd have a better look, I asked her how she felt....she said she was exhausted she couldn't believe she did it herself, she was quite proud so I congratulated her on that fact. Talked about a name for the baby and...about her other little girl...and tried to make the environment nice.

I was a little bit hassled. She had a graze which wasn't clotting very well so we put a pad in there to try and stem the flow ... explained we might have to get a doctor to suture.

During the delivery of the placenta, Kate was able to provide a concise description of her actions. At this stage of her professional development and at the end of her formal learning Kate's actions were certain. Her developing discipline specific knowledge demonstrated her practice ability and conditional knowledge to reason and make accurate decisions.

Amy and Kate both demonstrated that they based the care decisions on their prior knowledge and skills during the delivery of the placenta.

Amy's Reflections

Amy reflected on her twentieth birth below:

I didn't have a plan, it was so quick...apart from the time trying to deliver the anterior shoulder, and Rachel [midwife] prompted me to lift up. I think it all sort went to what I expected. The head delivered I checked the cord, and all the usual stuff. I realised I was stretching the perineum beyond belief and needed to come back up the other way.

She was a drug and alcohol lady...I am actually surprised that the birth went so well because I've been with you know ladies and you can't touch them, you can't go anywhere near them.

No apart from the anterior shoulder I think it all sort of went vaguely to plan.

Amy's reflection on the processes:

Just the fact that...I tended to pull down too...//...long on delivering the anterior shoulder. I know I have to get that under control. I just don't think...at the shoulder delivery, where it is and I should be coming back up the other way, and I don't want to do anybody any damage. The other [birth] I did was on all fours and I was sort of behind her so I couldn't really see that the shoulder, and Mary [midwife] actually said it has to become a thing of feel...spread out as it comes out. I think that's about the only thing because I have noticed I have done it a few times. Just that even now it just seems you get used to the whole blurry feeling where it's not in slow motion. It is still a bit unreal, you try and say all the right things but you find that you are still echoing the midwife. I mean you are about to say it and then they say it. So it is not always easy to have control of a situation, it just seems like a bit of a blur but as you are going through it you can see things happening you can see the head rotating and sort of talk to yourself and tell yourself you are seeing these things happening. It is really bizarre. It probably will be for quite some time.

The delivery of the baby's shoulder was a concern for Amy and this suggested there were gaps in her knowledge. As a result this limited her skilled practice (procedural knowledge) and caused uncertainty, when it came to the delivering the baby's shoulders. She was hesitant with her identification of data cues. For example, during the delivery a discussion occurred with regard to the procedure for the release of the anterior shoulder from under the symphysis pubis; on reflection Amy suggested it was released however, at the time accepted the decision of the CNE to be correct. Her insight into the situation suggested that as a student she didn't have the authority in the birth setting at this beginning stage of her professional practice. For example her comment that '*...you are about to say it and then they say it*' demonstrates difficulty with applying her practice knowledge and make the decision. Amy's practice level is suggestive of Benner's (1984) advanced beginner, by the continual development of her knowledge structures.

Kate's Reflections

Kate's reflected on her twentieth birth and explained:

...we did plan to deliver on the birth stool and then when she told me that she'd had perineal trauma in the previous birth I thought that she would be better delivering on her all fours. I think she just was happy to have anything for a delivery on the bed requiring any intervention. Her and her husband were really receptive to any suggestions...she wanted and was really quite happy to deliver on all fours.

Kate's reflection on her birth practices:

I was just disappointed with the fact that the suction equipment didn't reach over because that was a concern for me if something had really gone wrong...that could have been a big thing...if the baby had aspirated, I think that's just an unfortunate thing one of the set-ups in that section, the hospital has a big roll of suction cord where you basically can reach any part of the room whereas at the other hospital they have these little tiny reusable suction things that need to be sterilised. If I was going to do a birth like that again I'd have to position the woman perhaps closer to the equipment. It really hadn't occurred to me the fact that the suction equipment wasn't going to reach because I'd been used to doing births where it had. I was pedantic about checking the resus trolley itself, but I hadn't actually thought about the fact it didn't have on wall suction.

I'm pleased I got an intact perineum after all that and she was very pleased.

In the preparation for birth Kate discussed with the woman options regarding birthing positions. As the woman's labour progressed and her previous history had been noted, Kate was able to reconsider her decisions and offered the woman a different option more suited to her past history and this led to a positive outcome.

Amy's Knowledge and Reasoning

Amy explained her knowledge of birth:

I suppose from all the other deliveries and I had Rachel there coaching me, which was good. I mean when I was bringing too much downward pressure to deliver the anterior shoulder she pointed out I had to come back up again. It [the baby] was already out. I obviously didn't think it was out far enough. From all the other births and doing the same thing going through my mind, this is going to happen next that's what I have to do and...//...just following through a sequence of events. Just from seeing the look of the baby each delivery and in the anterior position...//...it was just sort of straight forward.

... The text books: I think you learn so much more from the practical. The theory is something but to see it happen that is how you really learn. So I'd say probably from the text books and the theoretical but I feel that I learnt a lot more from watching all the other births and having that coach there as you are delivering. There is nothing like hands on experience, the book can tell you so many things but until you actually there holding the head or trying to suction or stopping it from coming out ... I think it's instinct in a way. Sometimes you have a gut feeling about something and you see that it might be coming differently and you just have a bad feeling about it or a good feeling about it. Practical experience...from talking to the women and watching the women, as they are

delivering, watching their behaviour and getting to talk to the other midwives in the unit and their experiences.

During the birth or as you are actually [talking to] women little stories come out from them or that gives you a bit more insight into what's happening because, I said when a few things are happening all together then I might not be putting it together. I might be seeing them separately, the different signs, and I might not be putting them together. Or I'll go in see something and say I am worried about this and they'll come back and say don't worry because that's all right. I suppose from them [midwives] I get a huge assistance, in the middle of a birth or during the labour or in the tea room, in the corridor talking about them, their intuition is spot on usually.

I think I am just developing. Sometimes I've got it right or seem to have picked up on what was happening, but other times as I said I don't always see the big picture. It is good to have them around. They calm me down when I think there is a major catastrophe happening here and its nothing at all. As one said to me the other day students [are inclined] to look for the abnormal, don't look for the abnormal it will pop up and hit you on the head fast enough. We are taught the abnormal so I find that's always so reverberating in our head and we want to catch it before it's lost.

By the end of the program Amy was continually reconstructing her discipline knowledge, which is evidenced in her data. Amy often relied on the knowledge and decision making of other midwives with practice knowledge and skills. Amy was sensitive to why her practice knowledge and decision making skills were unsure, explaining '*...that she was unable to see the bigger picture thus far*', clearly demonstrating her level of expertise. Her ability to link the categories of birth knowledge together and make accurate decisions indicates that the structure of her knowledge base was still developing.

The structure of developing knowledge relies on the integration of declarative, procedural and conditional knowledge into networks of accessible semantic knowledge structures, rather than sheer quantity of knowledge (Balla et al., 1990; Boshuizen and Schmidt, 1992; Patel et. al., 1988). The structure of knowledge was found to be important to the success of students' reasoning in the study of Balla and colleagues. In Amy's case, her integrated birth knowledge structures are incomplete. To confidently identify data cues and make the links with her prior knowledge to reason accurate decisions appeared to be fragmented and by not having these links caused her to hesitate and question her knowledge.

Kate's Knowledge and Reasoning

Kate explained her knowledge of birth below:

I didn't need any instruction from the senior midwife that I was working with, I think it's because I've done several deliveries on all fours now and I've seen other midwives do deliveries. I've learnt by...talking with the people that I've worked around and done 19 deliveries. I'm one of those people that I see

something and I think that's a good idea I'll do that next time for me. I suppose it's a theory that I learnt at Uni and a combination of what I've learnt in the clinical field. Probably would be from my own experience which is quite limited, but mainly watching the midwives and doing births with other midwives. I mean you learn in theory at Uni but it's got to be consolidated with your practice.

Kate spoke about how she was able to learn from others and her own experiences. The formal knowledge and experience gained contributed to her ability to reason the options. Kate explained her ability to perform this current task and to reason the woman's birth position with her prior knowledge and success with previous cases, which were now incorporated in her everyday practice. These experiences have transformed her knowledge into schemas of discipline knowledge which allow her to successfully manage the birth task – qualities characteristic of a competent nurse and midwife (Benner, 1984).

Discussion – Levels of Understanding after the Students Twentieth Birth

After completing their twentieth birth the student midwives are at the end of their program, and no longer 'students'. In Benner's (1984) proficiency practice levels they are classified at this level of practice as 'advanced beginners' in their speciality. However, Kate indicated some characteristics of the competent practitioner, the next proficiency practice level.

Amy's and Kate's data are representative cases in the development of all the students in the group. There are individual differences between the degree of certainty in the student midwives practice and knowledge levels. Amy demonstrated some relevant aspects of the task through her learning and experience; however her actions were hesitant when reasoning, and marginally satisfactory with task functions. This practice is suggestive of Benner's advanced beginner, where the midwife's task used some integrated discipline and practices knowledge.

By the end of the program Amy was continually re constructing her discipline knowledge, which was evidenced from her data. Amy relied on the knowledge and decision making of other midwives on occasions. Amy was sensitive to the gaps in her practice knowledge and decision making abilities by her account '...that she was unable to see the bigger picture thus far'.

While Amy could independently function in some aspects of the task, her thinking appeared to be concentrated on the interrelated multiples of declarative (facts) and procedural (skills) knowledge with some evidence of conditional knowledge in her reasoning. Her level of thinking was in the transitional stage and still developing, which is demonstrating the multi-structural level of understanding with some features of a relational level of understanding (Biggs and Collis, 1989; Cantwell, 2004). Although her knowledge development and thinking were changing, she was yet to complete the first cognitive shift linked to the relational level of understanding.

Amy did demonstrate her knowledge had developed from the first to the twentieth birth. The number of differences between the quantity and quality of her coded recall protocol segments appears in four phases of assessment, delivery, afterbirth and reflection in figure 5.1 below. Amy's quality of knowledge is represented by the abbreviation **nr** (no relevant data); **sr** (some relevant data); and **hr** highly relevant data.

--- first birth
 --- twentieth birth.

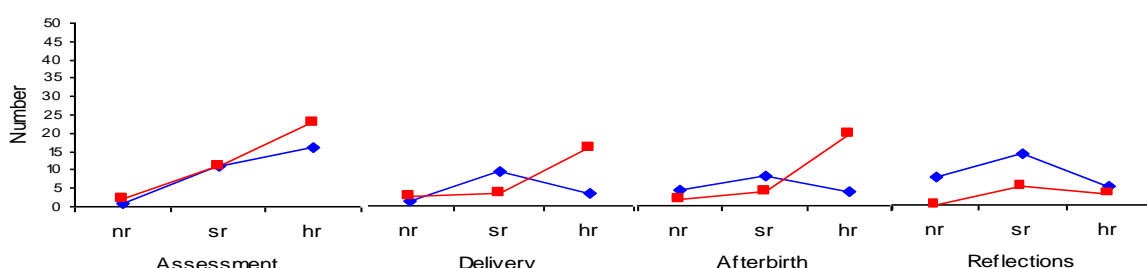


Figure 5.1: Number of knowledge segments, in four birth phases of Amy's data

The change in Amy's level of understanding from the first to the twentieth birth is shown in figure 5.1 and indicates the minimal use of her quality data in the first birth (blue line) across the assessment, delivery and afterbirth phases compared with the twentieth birth (red line) some 12 month later. Data in the reflection phase highlighted her uncertainty with the task and her responses in the some relevant data were higher in Amy's first birth than the twentieth birth. A similar trend was found in Kate's data; however the quantity of her verbal segments were higher than Amy's, which indicates Kate has a more comprehensive knowledge base.

Kate's level of understanding moved from the first birth to a more conceptual thinking described by Cantwell as the *first cognitive shift* in thinking (2004). Kate had structured her discipline specific knowledge with practice and reasoned using her conditional knowledge. The networked categories of the woman and her baby, the practice setting and her personal practice knowledge had changed in the period from the first to twentieth birth to form her understanding of a normal birth as whole, rather than components of birth knowledge which gave confidence to her decision making ability. The developmental change is demonstrated by the difference between the quantity and quality of Kate's coded recall knowledge in protocol segments, which appear in four phases of assessment, delivery, afterbirth and reflection in figure 5.2. The quality of her knowledge is represented by the abbreviation **nr** (no relevant data); **sr** (some relevant data); and **hr** highly relevant.

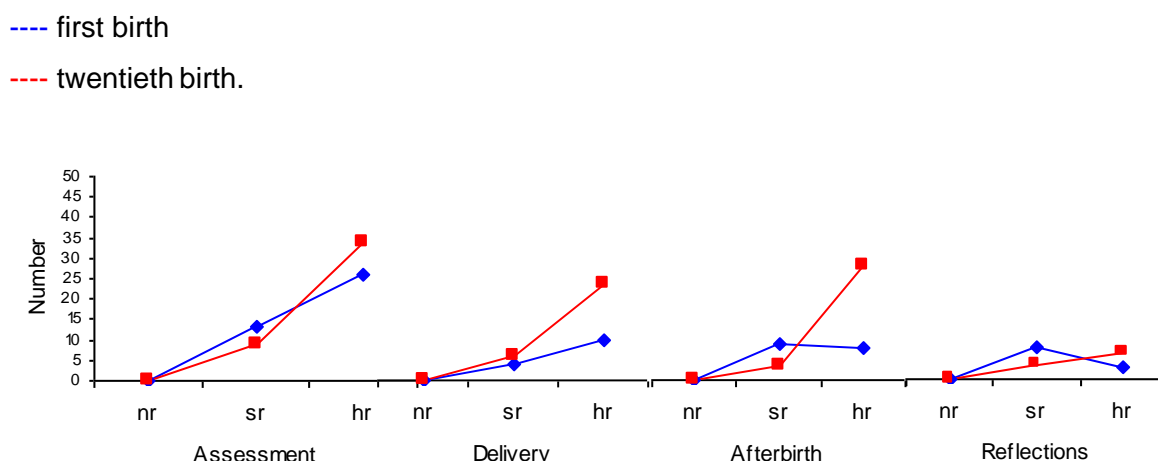


Figure 5.2: Number of knowledge segments, in four birth phases of Kate's data

With this knowledge Kate was able now to reason by linking data cues with her observed prior knowledge and make her decisions with certainty. For example, a change of birth plan because '*...then when she (woman) told me that she'd had perineal trauma in the previous birth I thought that she would be better delivering on her all fours and this would lessen the likelihood of trauma during the birth*'. Kate reflected and re-evaluated the initial plan to use the birthing stool and made a clinical decision by reflecting on the evidence of woman's previous history. The use of data cues from a number of sources to make care decisions reflects the relational level of understanding, the first cognitive shift in thinking (Cantwell, 2004). The difference between this and the multi-structural level is in the nature of the relationship between the knowledge categories. Knowledge categories have integrated into networks of coherent and discipline specific structures of prior declarative and procedural knowledge. The integrated knowledge networks or schemas of categorised information

results in a shift from a quantitative accumulation of information into a deeper understanding of a topic (Biggs, 1999), along with the formation of conditional knowledge structures.

Kate's knowledge had transformed. This was demonstrated by her ability to reason and make accurate clinical decisions using conditional knowledge; and knowing what to do and how to do it and the when and why under difficult birthing situations (Cioffi, 1998; Danerek and Dykes 2001; Greener 1988).

Kate utilised more quality knowledge overall in comparison to Amy, for example in the assessment phase Kate scored 28 (first birth) and 34 (twentieth birth) whereas Amy's were 16 (first birth) and 23 (twentieth birth) respectively. There are differences in the development of individuals' knowledge bases and each develops at their own pace with some taking longer than others. In addition differing contexts may also contribute to some variation within each student's data.

Amy's and Kate's data are typical of all students' knowledge in the coded protocol segments (see appendix 12 – for all students' coded data graphs). The graphs demonstrate the difference between quantity and quality of students' knowledge. They recalled more highly relevant data in the twentieth birth and the recall of their no relevant data had decreased.

Part Two

The Experienced Midwives Setting the Scene

Midwives in the study are experienced and independent practitioners. Together they have an average of 16 years experience (a range of 5 to 27 years) as a midwife in the delivery suite, and they attended an average of 540 normal births within a range of 200 to >1000 births. Twelve midwives in the study have undergraduate nursing certificates with an average of 3.6 years as Registered Nurses. Five held a post graduate midwifery qualification; two have Graduate Diplomas of Midwifery; and three have a Master of Midwifery degree.

Midwives' data, recalled after performing a normal birth, are varied. Two midwives, Jane and Claire (pseudonyms) were selected as representative cases in the analysis. The range of all midwives' protocol segments, represented in levels of relevance of data recalled during the normal birth, appears in table 5.7 below. The levels of relevance are illustrated by the abbreviation **nr** (no relevant data); **sr** (some relevant data); and **hr** (highly relevant data) for each midwife.

Table 5.7: the number of all midwives' protocol segments in levels of relevance

Midwife Name	Protocol Segments		
	nr	sr	hr
Pearl	0	22	101
Daphne	0	36	72
Doris	0	18	92
Fern	6	13	67
Lilly	0	13	54
Jane	0	37	108
Vikki	0	14	79
Claire	0	18	95
Kerri	0	52	122
Anita	0	10	93
Sybil	0	16	89
Fleur	1	9	51

The means and the standards deviations in levels of relevance of the midwives' protocol segments are shown in table 5.8.

Table 5.8: the means and standard deviations of midwives' protocol segments in levels of relevance

Group	Midwife N = 12	
	Mean	S D
All protocol	nr 0.25	0.43
segments	sr 21.5	12.66
	hr 85.25	20.27

The individual scores by Jane (108 highly relevant knowledge protocol segments for her birth) and Claire (95 highly relevant knowledge protocol segments for her birth) are typical of the group's scores. These details demonstrate the average of all the midwives' group and validate the choice of Jane and Claire as typical midwives of the group.

Level of Understanding – the Experienced Midwives

The aim of experienced midwives' data analysis is to understand the structure of their discipline specific knowledge used when making care decisions and recalled when performing a normal birth. The analysis is reported in the chronology of birth and the specific sequence of assessment, delivery, afterbirth and reflection phases. At the end of the phases midwives describe their knowledge of birth and reasoning processes. The analysis of the midwives Jane and Claire is presented singly and begin with Jane's management of a normal birth, then that of Claire.

Midwife Jane had performed 760 births during her 19 years of experience. Aged 50, she works as a fulltime Clinical Midwifery Specialist (CMS) in the hospital's delivery suite. Jane was hospital trained in the apprenticeship style with three years Registered Nurse experience prior to commencing midwifery. Jane has no post graduate nursing or midwifery qualification.

Jane's Assessment

Jane demonstrates her assessment decision below:

I knew she [woman] was ready to have her baby because she told me and...that she knew her body fairly well and told me she wanted to push and probably one of the few ladies that I haven't actually done an examination on to check...shortly afterwards we could see the baby's head. A visual assessment of her and listening to her. She had started getting a bit sweaty on the top lip and actually opened her legs wider, which I often find is a good sign of a baby coming down and things progressing along fairly quickly. A very definite, the baby is coming [midwife emphasis on the words] and then she had a very typical grunt of a lady who was ready...[and] she had overwhelming urges to push.

Jane describes the woman's care plan:

...this baby was 34 weeks and had prolonged ruptured membranes. The first thing I thought was the care of the baby and informed the [Neonatal Intensive Care Unit] NICU...I spoke to the mother and said there would be some paediatric staff at the delivery. We just briefly spoke...what position she wanted to be in to deliver the baby on all fours...she also wanted her 4 year old daughter to be at the delivery. I felt that she actually waited for her daughter to arrive...before she got to fully [uterus fully dilated]. We'd discussed that if her daughter wasn't coping with being there what action we would take, the [woman and partner] mothers were on their way and the daughter could go out to them if she wasn't enjoying what was happening...they were very flexible. I had spoken about the syntocinon she would have the injection into her leg at the time of delivery.

In preparation for the delivery Jane:

...checked the resus trolley...and made sure all was well that the NICU [Neonatal Intensive Care Unit] team know that that we would need their assistance...set up the equipment we would need for a delivery checked the suckers...I do all these things while I am talking to the women...

Jane's thoughts during her preparation:

What a delightful couple they were...how together they were about things. Although she had been in hospital for 9 weeks and I would presume they did not have the space or the time to interact as a couple usually would as the time for delivery approaches. They knew each other well enough... a together couple...it just happened smoothly.

Obviously well supported by family...his mother had come from Canada to be...around at the time of delivery.

Listening to the baby making sure it was right, thinking of the problems associated with baby's 34 weeks prolonged ruptured membranes. I like to be organised...and I also like to organise for all disasters. I am probably over organised but I think about those things as I go along.

In the assessment phase Jane anticipated the care and while talking with the woman identified the support she expected for her birth. Foremost in this care was the safety of the woman and her baby. Jane explained that the baby was not at full term (34 weeks as apposed to 40 weeks), the woman's membranes had ruptured earlier and she had been

waiting in hospital for the birth during the previous 9 weeks. Jane described her assessment with confidence and accuracy.

Jane's Delivery

Jane describes delivery of the baby below:

...encouraging Mum...how she would actually ease this baby's head out rather than...expelled out fairly quickly. I...often suggest to the ladies, if they can listen I say little puffs and then a push, a little pant, then a push and was helping with her.

Making sure between contracting that she had the face washer and mouth full of water and listening for the foetal heart [beat] to make sure all was well.

Coordinating the coming of the paediatric team...as head was coming on view. Encouraging Mum to have a feel of the baby's head...she had a look with the mirror between contractions...[and]...making sure that her husband and daughter were OK. She was up on hands and knees...you can visualise the perineum very well...it [the baby] had well and truly crowned...placed my fingers on it to control it a little bit...we sucked at actively because...she'd ruptured membranes for so long I thought we'd get rid of...as much fluid as we can...supporting the head as it is starting to deliver. Wiping its face, and sucked again as the mouth appeared and then again.....in the space between the two contractions between the delivery of the head and the shoulders.

Talking to her and to her daughter about the baby's head...encouraging her with the next push...delivering the shoulders...drying the baby off after it was delivered onto the bed and encouraging her to have a look and see what sex it was because they were not sure. Clamping the cord fairly quickly and dad cut the cord...the baby went across to the paediatric team. I then turned her over onto her back; she was given syntocinon by Helen...and waiting for the delivery of the placenta.

Jane's thoughts throughout the delivery:

Probably not much apart from checking, watching that seems to take up all my thoughts. I am often oblivious to what's going on around in the room. Once I know....the people who need to be there have arrived and thinking...we will really need to actively suck out the baby.

Making sure she was safe, I can always think that when they are on their all fours that I'm always very careful about how they go over onto their backs after they have delivered. Sometimes they are a bit ungainly and she stood up on the bed and gave me a fright...I had the bed fairly high and then they stand up...looking to the general safety aspects and all is going well.

Communicating with the woman during the delivery is clarified below:

I usually do talk to them a fair bit. I tell them of what I can with the head coming up...some ladies like to know, you can usually pick the ladies that like to know why it is stinging. Give them brief explanations of what's happening so they know what the pain is that they are feeling...then getting the head delivered. Encouraging...a push and then a pant to ease the head out...and to feel the baby's head. Some ladies when they are on all fours can actually look through it and see their baby's head...I know that she actually had a quick

look. So I was probably talking to her about it and the family to have a look and see what sex the baby was...asking Dad if he would like to cut the cord...the baby would quickly go over to the resus trolley. Reassuring, saying that the baby sounds good as we were listening to the foetal heart [beat]...asking if she'd like a drink of water...did she want her face mopped.

Jane was monitoring a number of aspects during the delivery phase and planning for possible changes in care. Her thoughts during the delivery highlighted a general safety concern for the situation, because the woman's position was delivering on 'all fours' which means that after the birth of the baby '*...are a bit ungainly...I had the bed fairly high*'. Her focus was on the safety of those present throughout the birth, principally concentrating on the needs of a premature baby. The baby was six weeks premature and there was a fear that if the baby breathes fluid into its lungs it may require active resuscitation and subsequently cause long term breathing problems. The problem is avoided by anticipating the consequences and Jane had called NICU team to the room.

Jane demonstrated her professional practice and did not talk about every detail like the students. She discussed her thoughts while monitoring the situation and '*...apart from checking, watching...[and waiting]...I am often oblivious to what's going on around in the room. Once I know....the people who need to be there have arrived.*' Jane's comment on monitoring the situation illustrates the abstract nature of her discipline specific knowledge. For example, knowing the practice setting with all its complexity and a higher level of declarative, procedural and conditional knowledge, Jane responds in this abstract form that would not be possible without many years of specific practice experience. Jane was the primary care giver at this birth and clearly clarified her actions and thinking, and how she coordinated the team while attending to all aspects of care. Jane was positive in her role as the leader. These are characteristics of Benner's expert nurse (1984).

Jane's Afterbirth

Jane describes the delivery of the placenta below:

After the baby was born and dad cut the cord we waited for the delivery of the placenta. She had the syntocinon so it was a matter of...watching for the signs of separation for the delivery of the placenta. That all happened and I asked her to give a little push and out came the placenta. She had very little blood loss and after examining the placenta it was intact.

The baby went across to the paediatric team and after a good suction out it was fine, pink, crying and we warmed it again with another warm rug. We showed her the baby again before it went to NICU. And as far as I know it is doing fine breathing on its own.

Then we cleaned up the woman with dry pads and sheets to make her feel comfortable. Offered her a cup of tea, while the husband went with the baby into NICU and all the rest of her family came in. After that did some observations. And she was stable so she had a shower, did some observations again so she could go to the nursery to see the baby.

Jane's thoughts at this time remained on the baby:

...maybe that it went well for a 34 weeks baby and was so far doing well and she was well supported with her family around.

Communication with the woman involved:

I talked with her about the delivery and how well she went and about the baby...about the delivery of the placenta. How she had the injection for separation and that the fundus was firm and why I was feeling it and that she might feel a contraction and would need to push when I told her to. That's about all because then some of the family were with her.

The delivery of the placenta was not a concern for Jane and she gave clear examples of her rationalised actions and expectations. She demonstrated her conditional knowledge in a woman-centred model of care. Jane maintained a coordinating role in the room.

Jane's Reflections

Jane reflection on the birth:

All went according to plan. The four year old daughter didn't stay and we knew that might happen so we had a plan for that.

Jane's Knowledge and Reasoning

Jane reflected on her reasoning and task knowledge below:

I think some of its instinct, and...I have done it so many times before I don't really have to think much about it anymore. I am probably organised like a flow chart, if this fits and this happens, I do this, if this fits and this happens I do that and I think that's the way I look to a delivery. Suddenly meconium is seen I call the paediatric team...I think some of it is from learned experiences and some of it is just instinct. The rapport you built with the lady is about what they like, you can judge sometimes what people would like or not like in a delivery. Certain sets of circumstances you need to do something for those...so I think it is probably like a flow chart...certain things happen you do certain things and that's the way it works for me.

In this instance Jane clarified her task knowledge, cognitive organisation and response as a 'flow chart' constructed by her experiences of birthing. Clinical data cues trigger the access to Jane's 'flow chart' predicting certain behavioural responses in a series of expected and or unexpected midwifery care situations. Jane fits her flow chart to the data cues. For example '*...suddenly meconium is seen I call the paediatric team*'. This direct automatic retrieval of information is from a highly structured discipline specific knowledge base. The

discipline specific knowledge links data cues in causal significance as a whole to reason effortlessly (Benner and Tanner, 1987; Corcoran, 1986a; Corcoran 1986b; Pyles and Stern, 1983). The result is a sophisticated clinical decision making process and practice.

Discussion of Jane's Case Study

Jane was a midwife with 19 years' experience birthing women, and being the primary care giver, who was confident in her practice. She employed discipline specific knowledge to make decisions of care. Jane described her midwifery practice knowledge as a flow chart concept. Jane's flow chart was organised in normal birth and when data cues prompt a sudden change this triggers a further flow chart into action. This way of reasoning has simplified the complexities of reasoning and making decisions.

A similar process is described by Cioffi and Markham (1997) as heuristic techniques or short cuts to schemas of structured prior knowledge. Midwives by identifying data cues and linking them to observed pattern of prior knowledge, judge its value and draw a conclusion to reason and then make a decision. The process is often automatic and has been described as an unconscious level of cognition (Benner, 1984; Carnevali, 2000; Dowding and Thompson, 2002; Hamers, Huiger Abu-Saad, and Halfens, 1994; Higgs and Jones, 2000; Schmidt et al., 1990). These are the characteristics of expert behaviour and when discipline specific knowledge has been structured to a higher level of abstraction and reflects the extended abstract level of understanding, demonstrates a second qualitative cognitive shift in thinking (Benner, 1984; Biggs and Collis, 1982; Cantwell, 2004). Jane had insight into her midwifery practice knowledge, and described her practice as flow charts of integrated practice knowledge of past experiences. These experiences were synthesised into schemas of abstract discipline specific knowledge.

The quantity and quality of Jane's coded recall protocol segments appear in four phases of assessment, delivery, afterbirth and reflection in figure 5.3 below. The quality of Jane's knowledge is represented by the abbreviation **nr** (no relevant data); **sr** (some relevant data); and **hr** highly relevant data.



Figure 5.3: Number of knowledge segments in four birth phases of Jane's data

Jane used her quality discipline specific knowledge when performing the birth. Overall Jane recalled more quality (highly relevant data) with a minimal score for some relevant data which showed the knowledge an experienced midwife employed during a birth.

The second case study is midwife Claire.

Claire's Case Study

Claire was aged 39 with eight years' full time experience in the delivery suite and had performed >500 deliveries. She was a hospital based midwife trained in the apprenticeship style. Prior to becoming a midwife she had 3.5 years experience as a Registered Nurse, with a Diploma of Health Sciences (Nursing). Claire has no midwifery post graduate qualification however she planned to commence post graduate study at the beginning of the following year.

Claire's Assessment

Claire's assessment is explained below:

When she first started to involuntary push I thought that she might have been fully dilated. She'd had a bright show I wasn't quite sure because she'd previously had an epidural and a previous long labour and forceps delivery, so I wanted to be very sure that she actually was fully dilated and things were going along as I would anticipate. So I examined her and she actually had an anterior lip...//...a very small anterior lip of cervix [remained before fully dilated] with bulging membranes. So I ruptured the membrane...she was 41 weeks and I just wanted to make sure there was clear liquor [fluid], the foetal heartbeat I did was normal. She was uncomfortable so I rolled her onto her side for a few more contractions, and when she started to have her bowels open and again continue to involuntary push I thought that she'd probably be fully dilated so I let her do whatever she wanted to do, and after about 10 minutes the head came into view. She was pushing involuntarily, she said she could feel the head coming down, there was perineal bulging and a bright show was present.

Claire's plan of care for the woman:

...prior to the delivery I'd asked her did she have any special desires for delivering her baby, which she didn't, she said she wanted to be on the bed...on her back in a more or less semi recumbent position. I let her go ahead with what she wanted to do. My plan would be...whilst she was doing what she felt she needed to do, the foetal heart sounds were quite normal and that there was no problem with the baby I would assist her, but it felt that there wasn't any problem with the baby...ask her to co-operate with me and she was very happy about that.

In preparation for the delivery Claire:

...set up the delivery trolley and made sure there was an injection of syntocinon ready, made sure there was a sucker ready in case we needed it, made sure that the neo-natal resuscitation trolley was ready, set up and warmed for the baby, and made sure that the mother was well aware of what was going to happen and how things would happen.

Claire's thoughts during the assessment phase included:

...thinking about getting ready I was thinking systematically about what I had to set up and whilst I was doing that I was talking to the woman...telling her what I was doing and reassuring her and getting her to breathe through the contractions during that time because she was involuntary pushing at that stage.

In Claire's assessment of the woman's readiness to deliver past history cues of a previous birth were important and the length the pregnancy was taken into account in her planning decisions. For example Claire anticipated '*...if membranes are ruptured when the woman is 41 weeks then there would be a possibility of meconium stained liquor*'. This simple statement demonstrated many aspects of anticipated care and knowledge. The woman at 41 weeks is one week over her due date and the functions of the placenta begin to alter after 40 weeks. The associated complications are meconium stained liquor because if the baby becomes distressed, due to lack of oxygen, it may pass meconium into the liquor during the labour with the possibility of aspirating meconium stained liquor on its first breath. This may result in active resuscitation and cause the baby long term breathing problems. In this assessment phase Claire linked the data cues with her observed prior discipline knowledge in preparation for the delivery.

Claire's Delivery

In the delivery phase Claire described she was:

...talking to the mother mainly...encouraging her to push as the head was coming up, after each contraction the foetal heart was listened to as the head came up to crowning I...delivered the head. I had my hands obviously on the head and was supporting the head until the latest part of the head had escaped under the symphysis pubis and then my other hand was supporting the mother's perineum. And slowly...getting her initially to push and then to

breathe as the baby's head crowned, she did it really, delivered the baby's head slowly with minimal trauma.

I waited for the next contraction...I did check to see if there was any cord around the baby's neck because there was some foetal decelerations during that pushing period, so I thought that would either be cord compression or just compression, one of the two. So I just made sure there was no cord and, which there wasn't, the baby's colour was good when the head was delivered. We waited until the next contraction which came...2 or 3 minutes later, then the mother pushed again, I delivered the anterior shoulder; then the posterior shoulder and the baby with lateral flexion up onto the mother's abdomen.

Claire's thoughts:

...during the delivery of the head, the foetal heart was sitting on about 80 or 90, I was wondering if there was a cord around the neck and would obviously check that...anyway.

I was hoping that it would be a boy because the parents really wanted a boy...going through my head was the delivery of the head, and the cord.

Communication with the woman Claire explained:

I saw that the head was coming, or would have nearly crowned I asked her to push and have little pushes, not great big heaves. As the head was crowning I asked her to breathe through the contractions. And once the baby's head had delivered I told her that baby's head had delivered and asked if she wanted to touch the baby's head, which she declined. Then told her that I was checking...to make sure there was no cord around the neck, I told both parents that. Then with the next contraction...said she wanted to push, so I said that's fine push and I delivered the anterior shoulder. Once the posterior shoulder sort of came up I asked her again to breathe not to push so I could deliver it slowly, and again with minimal trauma, and then put the baby on her abdomen and asked dad to have a look at what they'd had.

Claire discussed her rationale for concern: the deceleration of the baby's heart rate and the compression of the head through the birth canal were noted and expected to recover when the contraction eased. The normal foetal heart rate is around 120 to 130 beats per minute (bpm) and in practice concern is noted if it goes below 100 or above 160 bpm. Claire adjusted and qualified her actions during the birth of the head, located the position of the umbilical cord to assess if that was causing deceleration of the baby's heart rate, identifying a possible deviation from the norm and she continued to stay focused. Claire demonstrated that her integrated discipline specific knowledge and experienced practice were used to reason and make clinical decisions during the delivery of the baby. She was confident in her communications with the woman as the delivery progressed and her care decisions were woman-centred.

Claire's Afterbirth

During the afterbirth stage Claire explained the delivery of the placenta below:

I talked to her about the baby and said congratulations to the two of them. The baby was being dried with a warm towel...and kept an eye on her blood loss. Once the cord had stopped pulsating I told her that I would be clamping the cord and cutting it and asked the husband if he wished to cut it, which he did do. The baby stayed on the mother's abdomen and she wanted to keep on cuddling it, and we just put more wraps on the baby. I didn't really talk to her too much more about the baby, there was another midwife with me who had determined the apgar scores, the baby's colour was good and it was breathing and crying lustily.

I kept a lookout for placental separation...watched her loss, which did actually become quite heavy prior to the delivery of the placenta.

I thought that the placenta had separated I encouraged her actually to push the placenta out rather than to use controlled cord traction. The reason for that being the cord was only thin and looked a bit fibril. I didn't really want to pull on the cord and perhaps pull the cord off the placenta. I also told her about the syntocinon injection...she knew that she'd had as the baby was being delivered.

Claire's thinking at the time:

I suppose I was thinking isn't it great these people had a little boy. Ensuring that the cord...pulsation had stopped...the cord being clamped and cut. My first initial thought was this is great, the parents are delighted, they're really happy, they've got a seemingly healthy looking baby and they have a little boy and they were really happy.

I was thinking I wanted to get the placenta out because she'd had a fairly heavy [blood] loss, and I was thinking...I won't use controlled cord traction because the cord looked so thin and I didn't want to pull the cord off the placenta. So my thoughts were I want to get this placenta out and get it out as soon as possible.

Claire's conversation with the woman involved:

I told her how happy I was for her and her husband, both were very grateful and very happy with the outcome, and so we talked about that. We talked about the baby and the things I would be doing to get her afterbirth out once the cord was cut...you're bleeding a bit here so I'd really like to get the afterbirth out...the afterbirth has separated...when you get another contraction I want you to push. I'll palpate and feel, if you're getting any contractions...after the placenta was born I told her I was going to rub up the uterus and for her to continue just looking at her baby...as it wouldn't be very pleasant. I told her once the loss had settled and I was happy with the uterus, I was going to look for any tear or lacerations and this also wouldn't be particularly pleasant...and for her to tell me if I really hurt...told her she didn't need stitches and she was very happy about that.

The afterbirth phase had proceeded to a normal progression. Claire observed an increase in blood loss, and adjusted her actions to accommodate the changes, and quickly made her decision. She diverted from the normal process not to use cord traction to deliver the placenta but discuss a further option with the mother. With her agreement Claire successfully managed the situation. Also her experienced judgment of the situation

successfully managed the emotional state of the parents, demonstrating her professional practice.

Claire's Reflections

Claire reflected on the birth outcome below:

I'm happy with what I did, the parents seemed happy with what I did, which I think is very important. Had the parents been unhappy, yes then I would have...been concerned...it was all very straightforward, there weren't any real complications.

In this instance Claire was satisfied and confident with the outcome.

Claire's Knowledge and Reasoning

Claire reflections on her birth knowledge and reasoning are below:

I guess its reflex now...you don't consciously think about what you're doing with an action that you have done so many times before. However the only time I was thinking consciously about something that I would do is when there was this part of the head came up and that I would check if there was anything there, around the neck or coming down with the shoulder. And for the rest...it had been something that I learnt a long long time ago and I guess have done many times and whilst it's experience, each delivery is a different experience, it's a reflex thing [her practice], it just comes. It's like driving a car, you don't actually think about you know, once you're proficient I guess at driving a car, then you don't give much thought about driving but you do know what to do and, I think it is sometimes reflex, when situations occur that you're unprepared.

Claire described her practice reasoning as a 'reflex' and likens it to the reflex actions you have when driving a car. Claire was proficient in the task. She described that her skilled action has become automatic with little thought, particularly in unexpected events. It appears Claire has learned and arranged the birth tasks into responses and actions where data cues trigger a sequence of care behaviours instinctively. The actions come into play effortlessly and without further thought. The data cue triggers that prompt structured knowledge of care behaviours were described by the literature as heuristics (Cioffi and Markham, 1997).

Discussion of Claire's Case Study

Clare is an experienced midwife with eight years' experience working full time in a delivery suite. As the primary care giver at this birth she was confident in her practice and made her care decisions based on discipline specific knowledge. Claire's insight into her discipline specific knowledge was likened to 'driving a car'. Once proficient in practice, little thought

was given to the decision making process (Benner, 1984). This automatic reflex of behaviours has been developed from past experiences with different births over time. For example, describing the birth of the head in relation to where the baby's cord might be situated alerted Claire to an area of possible concern. She became aware of the unusual pattern of the baby's heart beat and this also triggered her concern.

The reflex action, likened to the analogy of driving a car to the context of birth, is triggered by data cues which link to actions that are automatic and initiated without effort, and are identified as schemas of abstract thinking (Benner, 1984; Carnevali, 2000; Dowding and Thompson, 2002; Hamers et al., 1994; Higgs and Jones, 2000; Schmidt et al., 1990). Claire's practice reflected her extended abstract level of understanding, in the second qualitative cognitive shift in thinking, which characterises the expert (Benner, 1984; Cantwell, 2004).

The quantity and quality of Claire's coded recalled protocol segments, in four phases of assessment, delivery, afterbirth and reflection, is shown in figure 5.4 below. The quality of Claire's knowledge is characterised by the abbreviation **nr** (no relevant data); **sr** (some relevant data); and **hr** (highly relevant data).



Figure 5.4: Number of protocol segments in four birth phases of Claire's data

Claire used quality discipline specific knowledge in decision making when performing the birth. Overall Claire recalled more quality (highly relevant data) with a minimal score in some relevant data, which showed the knowledge an experienced midwife employed during a birth and highlighted in her case study analysis.

The range of midwives' data varied. Jane's and Claire's protocol segments are typical and reflect all midwives in the group (see appendix13 – midwives' data graphs). The midwives

data graphs demonstrate the difference between quantity and quality knowledge of all the midwives in similar trends to that of the representative cases of Jane and Claire. The trend illustrates the quantity of midwives' quality (highly relevant) knowledge.

The case studies showed Jane and Claire were able to articulate how they have arranged their integrated discipline specific knowledge, demonstrating its accessibility. Advanced in their practice and with high order thinking abilities and critical thinking skills, Jane and Claire demonstrated they that are metacognitively aware.

Discussion

The purpose of the case study analysis was to examine the growth and structure of student midwives' knowledge when making clinical decisions during a normal birth compared to that of experienced midwives. The analysis used the narrative data of two students (Amy and Kate) and two midwives (Jane and Claire) who were representative of the whole group. The student midwives described how the quality of their understanding changed from the first to the twentieth normal birth. Their knowledge developed, by varying degrees, from a loosely structured beginning into integrated networks of discipline specific knowledge. The changes in thinking reflected the students' level of understanding. On the other hand, the experienced midwives used abstract schemas of discipline specific knowledge to explain their sophisticated clinical decision making process.

Benner's Model of Professional Nurse Development and Cantwell's theory of cognition model representing levels of understanding outlined in chapter three provided the framework for the analysis (Benner, 1984; Biggs and Collis, 1989; Cantwell, 2004).

Student Midwives

The students performing their first and twentieth births were continually supervised by an experience midwife or educator. To master 20 normal births their learning takes place in the delivery suite, which is the natural setting of the discipline, with all its complexity and uncertainty. Boshuizen and Schmidt (1992) and Schmidt and Boshuizen (1993) found that when students become involved with patients and their care, knowledge starts to integrate and the real world of practice introduces more variability in decision making practice and skills (Hoffman, Aitken and Duffield, 2009).

Levels of Understanding - Students' First Birth

The student midwives performing their first birth were representative of beginning learners. Their prior knowledge of the task consisted of formal lectures, practice observations and classroom practice. The quantity and quality of their prior knowledge is limited during the beginning stages of learning and practice which often leads to the inability to access the meaning and significance of data cues and reason beyond reporting the facts. These are characteristic of the novice (Benner, 1984; Boshuizen and Schmidt, 1992; Patel et al., 1988; Patel et al., 1993; Woods, Brooks and Norman, 2005).

The limited problem representation and weaker knowledge association with the task by one student (Amy) was emphasised by her list like recall of declarative knowledge and her limited knowledge transfer of prior knowledge into practice. The pieces of unrelated knowledge were stored in memory as fragmented structures of declarative knowledge: knowledge of anatomy and pathophysiology of a woman and her foetus; the chronology of birth; and midwifery care information. This loosely organised knowledge base makes it difficult for the student to distinguish between relevant and irrelevant information when considering clinical data cues. This has also been found in novice studies (Azzarello, 2003; Boshuizen and Schmidt 2000; Bordage and Lemieux, 1991; Patel and Groen, 1986). This beginning practice is supervised and the student's thinking is transitional, reflecting a moderate multi-structural level of understanding (Biggs and Collis, 1989; Cantwell, 2004; Chan, Tsui, Chan, and Hong, 2002).

Student Kate's practice had associated some meaning and significance from her prior knowledge and beginning experience. She had begun to connect common pieces of birth knowledge and was developing some depth and breadth of declarative knowledge structures and practice. However, knowledge structures during this developmental stage were loosely connected; and her reasoning in practice was focused on more concrete and surface meanings applied to clinical data cues (Cantwell, 2004; Hassebrock and Prietula, 1992). As a consequence her knowledge development was transitional and her thinking reflected the uni-structural and beginnings of the multi-structural levels of understanding (Biggs and Collis, 1989; Cantwell, 2004).

The changes in thinking through the different levels of understanding are not abrupt but singly transitional (Cantwell, 2004). The two students' loosely structured knowledge base is

typical of beginning practice in midwifery and the quantitative findings did identify the limited quantity and quality of their knowledge.

Levels of Understanding - the Students' Twentieth Birth

The students recalled their twentieth birth, at the end of their program, and demonstrated a change in thinking. Their level of understanding had progressed from a loosely structured beginning to develop a depth and breadth of birth knowledge with increased knowledge and practice experiences.

With increasing experience knowledge structures were transformed by direct lines of related midwifery knowledge, connecting, clustering and then processing them into distinct networks of knowledge categories. This network of knowledge categories is unconnected during this developmental stage (Cantwell, 2004). Midwifery knowledge of a normal birth, identified in chapter three, comprises networks of woman and baby, midwives' practice and the birth setting knowledge which begins to form during the course of their learning and is repeated by use of their knowledge in practice. Knowledge transforms from remembering information to knowing information, and the quantitative accumulation of information. It changes to a deeper understanding of knowledge and practice. Students begin to understand normal birth as a whole, rather than as separate categories of birth knowledge. With this knowledge they now have the ability to distinguish between what data cues are important and relevant to the task and what are less important to reason decisions by drawing on prior knowledge, rather than constructing each decision from scratch. Most students are independent in their practice because of repeated experiences of similar patient situations; however they may lack speed and flexibility (Benner, 1984).

The students' practice experiences had developed patterns or schemas of discipline practice knowledge, which continue to form and reform by the process of rethinking and reforming structures of past clinical situations. These developmental changes in thinking are facilitated by the reflective and evaluative processes (Tanner, 2006). These continue as self-awareness processes describing the critical link between knowledge development (Cahill and Fonteyn, 2000) and the development of critical thinking skills, in the construction of more sophisticated knowledge. Facilitating formalised self-monitoring strategies of being adaptive, willing to change and most importantly to have knowledge of one's strengths and weaknesses will strengthen the learners' own recourses and develop independent thinkers (Pintrich, 2002).

Student Kate's twentieth birth illustrated her ability to take into account the woman's history and make a change to her original plan. She rationalised the reason for the change with the woman suggesting it would be better delivering on all fours. The relevant data cues from the woman's history were selected to formulate a care plan and make decisions. This understanding developed as Kate reflected on her previous experience with similar deliveries and when she had observed other midwives' practice. Kate reflected her knowledge, integrated prior knowledge and made her decision using conditional knowledge. This reflection and evaluation of linking data cues with observed prior knowledge and past experiences, demonstrated how the decision was made. Her practice had changed from her first to twentieth delivery, which reflected a qualitative cognitive shift in thinking at the relational level of understanding (Biggs and Collis, 1989; Cantwell, 2004).

On the other hand Amy's knowledge development from her first to twentieth delivery was transitional, with features of the thinking at the multi-structural level of understanding. However some data did reflect her integrated knowledge which is a feature of a relational level of understanding and the first cognitive shift in thinking.

With this discipline specific knowledge students were now able to distinguish between what prior knowledge is important and relevant, and what is less important in order to reason clinical decisions by a process of selective judgment. These characteristics have also been displayed in studies in a similar level of nursing and medical students (Benner, 1984; Itano, 1989; Patel et al., 1988; Tanner et al., 1987). The quality of their knowledge was directly linked to readily assessable structured knowledge. The relationship between the quality of reasoning and the accuracy of the diagnosis was also identified in nursing and medical studies (Balla et al., 1990; Cholowski and Chan, 2004).

Experienced Midwives

Level of Understanding – the Midwives

The midwives described their practice knowledge in clinical schemas that were characterised by synthesised knowledge and experiences, as abstract clusters of structured knowledge networks of reasoning strategies. The two midwives described their reasoning knowledge in a 'flow chart' or the reflex action of 'driving a car', constructed from previous experiences with birthing woman. Clinical triggers (patient data cues) prompted prior knowledge that predicts certain behaviour responses in a series of expected or unexpected midwifery care situations.

These abstract knowledge structures are characteristic of experiences. For example, Claire explained her practice as a reflex action now and does not '*...consciously think about what you're doing with an action that you have done so many times...the only time I was thinking consciously about something...was as this part of the head comes down...and (I) check (the cord)...around the neck or coming with the shoulder*'. Claire described how she unpacked her unconscious schema when a data cue triggered an awareness to consciously think about the procedure.

Similar features of expert thinking were foremost in Benner's proficient and expert proficiency practice levels (Benner, 1984). At this level Benner proposed reasoning is less likely to be a conscious process. For example, Jane demonstrated her professional practice and explained while monitoring the situation and '*...apart from checking, watching...[and waiting]...I am often oblivious to what's going on around in the room. Once I know....the people who need to be there have arrived.*' Jane was concentrating on monitoring and planning for possible changes in care during the delivery. Monitoring the situation is automatic as the expert is able to manage rapidly changing clinical situations while attending to many other aspects of care (Benner, 1984; Fowler, 1997; Patel and Groen, 1986).

Jane described how she coordinated the birth. This involved calling for the assistance of the NICU team because the baby was premature and may require resuscitation; the presence of the woman's 4 year old daughter while delivering the baby; and delivering the placenta and caring for the woman's requirements during the birth. Jane explained her knowledge and reasoning as '*...instinct now...[and]...I really don't have to think much about it anymore...I am probably organised like a flow chart*' which highlighted her discipline specific knowledge and expert practice.

Claire and Jane confirmed their ability to think critically about a situation and how they achieved the desired outcome for women (Price, 2004). For example Jane respected the mother's request to have her 4 year old daughter in the room and reasoned '*...if her daughter wasn't coping being there what action we would take...[because she could go out]...if she wasn't enjoying what was happening*'. Jane could foresee a risk in this situation and planned an alternative by exploring the situation, identifying any difficulty or risks to make logical and multiple alternatives to care. A further example in the assessment phase was when Jane described the baby was 34 weeks and the woman had prolonged ruptured

membranes and reasoned that *the ‘...first thing I thought of was the care of the baby and inform the NICU’*. Jane could foresee possible risks and instantly knew what action to take in planning, monitoring and evaluating the woman’s care, which confirmed her expert thinking and advanced practice.

The experienced midwives’ practice knowledge reflects the extended abstract level of understanding (Biggs and Collis, 1982; Biggs and Collis, 1989; Cantwell, 2004). This level of understanding (discussed in chapter three) has constructs of knowledge from formal learning, skilled experience and years of reflecting that have transformed knowledge into clinical schemas of specific discipline knowledge and practice (Bordage and Lemieux, 1991; Boshuizen and Schmidt, 1992; Cholowski, 1998; Hassebrock et al., 1993; Patel et al., 1990; Schmidt et al., 1990). The ability to integrate clinical data cues to focus on clinical situations immediately pre-empts causal significance. Evaluating care options to reason effortlessly is the key element in clinical decision making (Balla et al., 1990; Benner, 1984; Cioffi, 2000; Orme and Maggs, 1993; Pyles and Stern, 1983). These are reflective of a sophisticated clinical decision making practice.

Experienced midwives’ use conditional knowledge to reason and make clinical decisions and the literature identified that they also use intuitive knowledge (Cioffi, 1998; Hunter, 2007; Kelly, 1997; Mok and Stevens, 2005; Siddiqui, 1994; Price and Price 1997).

Midwives’ clinical judgement and competent professional practice are a synthesis of knowledge, experience and of advanced practice (Aitken, Faulkner, Bucknal and Parker, 2002; Davis, 1998; Mok and Stevens, 2005; Watson, Turnbull and Mills, 2002). Claire’s and Jane’s use of their abstract schemas of discipline specific knowledge in a sophisticated clinical decision making practice was typical of examples of the midwives group whose data are similar but expressed in individual terms.

An experts’ declarative knowledge has been described as being less prominent as it becomes subsumed into networks of accessible discipline specific knowledge (Balla et al., 1990; Boshuizen and Schmidt, 1992; Patel et al., 1988). The trend was not observed in this study because the analysis showed experienced midwives’ declarative knowledge remained prominent and appeared to be readily accessible. Midwives in the study worked in a teaching hospital delivery suite, where both midwifery and medical students are under consistent supervision by experienced midwives and clinicians. For that reason the midwives’ data contained declarative knowledge as highlighted in the narratives above and demonstrated the quantitative analysis, particularly during the assessment phase. The

normal birth is a continual process, each birth is discrete and the nature of woman's experience guides students' and midwives' decision making.

Chapter Summary

Two methods of analysis were used to examine students' and midwives' data. Firstly the quantitative results indicated differences between the two levels of students' (after their first and twentieth birth), and midwives' declarative, procedural and conditional knowledge segments recalled during a task. All did make use of their declarative, procedural and conditional knowledge. However, the quantity and type of quality knowledge between groups varied. The consistent use of quality knowledge was highest among midwives, reflecting their discipline specific knowledge. The quantity and quality knowledge of students after their twentieth birth was more aligned with that of the midwives. On the one hand, the students after their first birth had fewer applications of quality knowledge and more 'no relevance' and 'some relevance' knowledge segments than the students (twentieth birth) and the midwives. This implies a limitation on their ability to reason care decisions. On the other hand the results suggest that the type and accessibility of prior knowledge of a task is important to make sense of data cues and reason clinical decisions. The quantitative results contributed to a broad overview of students' and midwives' declarative, procedural and conditional knowledge which was then recalled when used to make clinical decisions.

The second section reported the qualitative analysis. It examined the development and structure of two students and two midwives' data in a case study technique. Their descriptive narrative data sets provided a story of the birth in the students' and midwives' own words. Data were analysed in levels of understanding to examine the structure of their knowledge. Students' knowledge transformed from fragmented, loosely constructed declarative knowledge, which demonstrated gaps and weaker knowledge associations in their first birth, to integrated patterns or schemas of discipline knowledge in their care decisions by the twentieth birth. There were individual differences in the rates of developmental change, which were not abrupt but occurred in transitional phases with each level of expertise moving through at their own pace to reach a skilled level of practice.

The midwives were found to reason their clinical decisions with a sophisticated network of abstracted clinical schema /s of discipline specific knowledge. Discipline specific knowledge is the integration of declarative knowledge with procedural knowledge, and continually

evolves with practice experiences. It formed links and relationships between facts, the task itself and patterns of specific clinical practice outcomes into conditional knowledge: is the nature of an individual's practice discipline.

The integration of prior declarative and procedural knowledge into conditional knowledge, transformed into abstract schemas of discipline specific knowledge was the basis for successful reasoning and clinical decision making. The experienced midwives are advanced in this practice, use higher-order thinking skills and are metacognitively aware.

As a result of these findings, chapter six will discuss the outcomes in relation to the study aims by drawing the two findings together. The conclusions and recommendations for learning within the limitations of the study are discussed. The implications for practice and recommendations for future research are also considered.

CHAPTER SIX: DISCUSSION AND CONCLUSIONS

(A)...midwife is recognised as a responsible and accountable professional who works in partnership with women to give the necessary support, care and advice during pregnancy, labour and the postpartum period, to conduct births on the midwife's own responsibility and to provide care for the newborn and the infant. This care includes preventative measures, the promotion of normal birth, the detection of complications in mother and child, the accessing of medical care or other appropriate assistance and the carrying out of emergency measures...

(ANMC, 2006 p.1).

The purpose of this study was to examine student midwives' knowledge growth and clinical decision making and compare it with midwives' knowledge and expertise while performing a normal birth task. To understand how students' knowledge develops compared with midwives' knowledge the study examined the following research questions.

- 1) What is the nature of the differences between midwifery students (after their first and twentieth birth) and experienced midwives in their use of declarative, procedural and conditional knowledge when making clinical decisions during a normal birth?
- 2) What is the nature of midwifery students' discipline specific knowledge after their first and twentieth birth when making clinical practice decisions?
- 3) What is the nature of experienced midwives' discipline specific knowledge?

The literature, reviewed in chapter two, established a positive relationship between a well-structured discipline knowledge base and high quality decision making. In order to understand this relationship chapter three proposed a 'theoretical' sequence that systematically predicted the development of midwifery students' knowledge and described the structure of experienced midwives' knowledge. These proposed developmental changes in students' thinking and the structure of midwives' knowledge were examined using the framework of the National Competency Standards for the Midwife, Benner's proficiency practice levels and Cantwell's theory of cognition model, representing the levels of understanding in SOLO terms; and the declarative, procedural and conditional knowledge from the midwifery, nursing and medical literature (Table 3.1 in chapter three) (ANMC, 2006; Benner, 1984; Biggs and Collis, 1989; Cantwell, 2004).

In order to answer the research questions outlined above, retrospective data, consisting of two sets from students (after their first and twentieth birth) and one set from experienced midwives, used recall of what they were doing and thinking while performing a normal birth task. The data were analysed based on a combination of qualitative and quantitative techniques.

The major findings from the quantitative analysis, using protocol analysis techniques, established that both the midwives' and the students' (twentieth birth) verbal protocols contained a greater number of high relevance declarative (knowledge), procedural (skill) and conditional (attitudes) knowledge segments compared to students' first birth. Based on these results the prior knowledge of the experienced midwives and students (twentieth birth) were more structured and more readily accessible compared to that of the students after their first birth. This analysis reflected part of the picture but because it did not reflect the development of their discipline specific knowledge structures, a second analysis was conducted using two students' verbal data (from first then twentieth birth) and the verbal data of two experienced midwives using a qualitative case study technique.

The case study analysis highlighted the students (after their first birth) loosely structured knowledge and displayed the gaps that limited their decision making ability. The students after their twentieth birth on the other hand, demonstrated the integration of their declarative and procedural knowledge, which forms the beginning of their discipline specific knowledge. They used their conditional knowledge, structured in patterns of past experiences, to distinguish between what knowledge is important and relevant and what is less important and relevant, to reason clinical decisions in a process of selective judgment. While a number of 'high relevant' knowledge segments from students (twentieth birth) and midwives were found to be similar in the quantitative analysis, the qualitative analysis identified that there was a difference in the structural complexity of the experienced midwives' knowledge. The structure of experienced midwives' knowledge was characterised by more abstract structures or schemas of discipline specific knowledge. Reasoning was automatic in nature and the midwives were able to manage rapidly changing clinical situations, and attend to other aspects of care, simultaneously. These major findings of the study matched the hypothesised knowledge structures of students (first and twentieth births), and experienced midwives as outlined in chapter three.

This chapter draws together the study's quantitative and qualitative analyses based on the findings discussed in chapter five. The discussion is divided into three parts. The first part

summarises the characteristics of discipline specific knowledge employed to reason clinical decisions between student midwives and experienced midwives. The second part describes the implications for the education of midwives as a result of the study's findings. The final part discusses the application of the findings to midwifery education and practice, the limitations of the study and recommendations for future research.

The Characteristics of the Students after their First Birth

The main characteristic of the practice of midwifery students after their first birth is their limited midwifery knowledge base. Their prior knowledge of birth consisted of information gained from formal lectures, classroom practice in the technique and observation of five normal births. This knowledge was structured as loosely connected information stored in memory as declarative and procedural knowledge. The gaps in their knowledge lead to weaker knowledge associations and were less successful in generating clinical decisions. This finding is consistent with other novice studies (Boshuizen and Schmidt, 1992; Patel et al., 1988).

A limited knowledge base meant they had difficulty in distinguishing between relevant and irrelevant information. They were found to 'make do' with the knowledge they had and support from an experienced midwife to recognise data cues. This impeded their ability to reason and make decisions (Azzarello, 2003; Benner, 1984; Corcoran, 1986a; Corcoran, 1986b; Hoffman et al., 2009; Tschikota, 1993). The beginning students tended to place meaning on individual items and often focussed on cues rather than reason from a more structured prior knowledge base. Schmidt's (1993) study of novice medical students' reasoning highlighted that *'...the availability of relevant prior knowledge is a necessary, yet not sufficient, condition for understanding and remembering new data, and the way it is structured in memory makes it more or less accessible for use'* (p.424).

The novices' knowledge base limited their practice to monitoring care in a list like manner with a reliance on procedure and practice routines (Benner, 1984; Benner et al., 1996; Hanneman, 1996). Beginners are more likely to monitor care without understanding, and are less likely to recognise inconsistencies in care beyond that of the surface meaning. The midwifery practice setting is often confusing and disjointed for beginnings students (Clarke, 2002). For example one student explained how she *'...was just dumbfounded...I was just listening and doing what I was told'*. The study established that this caused apprehension and uncertainty for this student's ability to reason and make care decisions.

These findings are not surprising, given their immature midwifery knowledge structure and limited experience with birthing. The findings are consistent with the characteristics of novice students in studies using knowledge driven reasoning models (Boshuizen et al., 1995; Hassebrook and Prietula, 1992; Patel et al., 1994; Schmidt et al., 1990).

The Characteristics of the Students after their Twentieth Birth

The most important characteristic that distinguished midwifery students from the first to their twentieth birth was their structured discipline specific knowledge, which underwent a transformation during the course of their learning and practice. Now, at the end of their program and the beginning of their professional practice as midwives, these students displayed similar characteristics to those of the experienced midwives in the study. The nature of students' reasoning however was not automatic and the structural complexity of their knowledge was less sophisticated than that of the experienced midwives.

At this level of expertise, declarative and procedural knowledge structures had developed into schemas of discipline practice knowledge. With this knowledge they employed conditional knowledge, in varying degrees, to reason with, as opposed to using their declarative knowledge as the basis for reasoning, as found in novice reasoning (Patel et al., 1988; Schmidt and Rikers, 2007). The nature of students' thinking after their twentieth birth was found to be different because the change in their cognitive knowledge and experience of the task had transformed. All students, in varying degrees, were able to demonstrate the relational level of understanding, reflecting the first qualitative cognitive shift in thinking inherent in the findings (Biggs and Collis, 1989; Cantwell, 2004).

This qualitative developmental change in thinking, from previously held assumptions, or perspective transformation, is assisted by a clinical expert / mentor (Oliver and Butler, 2004; Tanner, 2006). With guided assistance a gradual transfer of relevant self-regulatory or metacognitive strategies from the mentor to student occurs (Volet, 1991) and contributes to the development of students' critical thinking capacity as they construct more sophisticated discipline specific knowledge. This self-reflection and awareness, and the critical thinking abilities are important in the transformation of midwifery students' knowledge in the practice setting (Licqurish and Seibold, 2008). Medical students were found to use a similar process to regulate the effective use of their cognitive knowledge (Dornan, Boshuizen, King and Scherpbier, 2007). Without these self-regulatory abilities, the development of knowledge

affects patient care. It is likely to be a rote application of 'technical' knowledge and action that may lead to probable errors in reasoning care decisions (Greenwood and King, 1995; Hammond, 1996; Rivet and Jones, 2004).

At the beginning of their professional midwifery practice the midwifery students' patterns or schemas of structured discipline specific knowledge, together with less sophisticated decision making ability was predicted. It was consistent with similar levels of expertise identified in the literature (Balla et al., 1990; Boshuizen and Schmidt, 1992; Patel et al., 1988). Most students in the study were able to plan and prioritise care (Benner, 1984); and to work independently to varying degrees, which was related to their level of discipline specific knowledge and practice development. All students' practice is supervised and exposure to the academic process alone limits their decision making autonomy and subsequently their ability in the decision making process (Cioffi, 1998; Girot, 2000).

The Characteristics of the Experienced Midwives

Characteristics of midwives in the study are represented by their readily accessible discipline specific knowledge, structured in networks of abstracted clinical schema /s used to make valid and reliable judgments with less effort and greater accuracy. Expert practice represents a combination of cognitive and metacognitive knowledge and higher-order thinking abilities, advanced midwifery competence, and independence in decision making. The professional midwife, advanced in practice and with higher-order thinking abilities, has control of cognition by being metacognitively aware of their knowledge and practice.

With these characteristics, midwives display an extended abstract level of understanding which is represented by the second qualitative shift in thinking as predicted (Biggs and Collis, 1989; Cantwell, 2004). This is similar to attributes of Benner's proficient and expert proficiency practice levels (Benner, 1984).

The nature of experienced midwives' knowledge illustrated their abstracted discipline specific knowledge structures in patterns of automatic responses. One midwife in the study had likened her decision making practice to a 'flow chart' and explained it is instinctive saying '*...I am probably organised like a flow chart, if this fits and this happens, I do this, if this fits and this happens I do that*' (Jane). Another compared it to the reflex action of driving a car (Claire), the midwives' 'bag of tricks' was another (James et al., 2003) or a framework of heuristics (Cioffi and Markham, 1997). All described midwives' reasoning strategies.

These predictive representations of certain behaviour and action responses are triggered by data cues, and in a series of expected or unexpected midwifery care structures in memory, the nature of which is automatic and effortless often without further thought (Hughes and Young, 1992; Schmidt and Boshuizen, 1993).

Boshuizen and Schmidt (1992) have referred to similar types of predictive reasoning strategies in expert medical clinicians' practices, which are represented by the terms 'illness scripts' and 'schematic structures of past experiences and knowledge' (Balla et al. 1990; Corcoran, 1986a; Corcoran 1986b; Patel et al., 1988). The structural complexity of these broader multiples of abstracted discipline specific knowledge is in the various descriptors of experts' reasoning strategy processes in the knowledge driven model (Boshuizen and Schmidt, 1992; Boshuizen et al., 1995; Cioffi and Markham, 1997; Grant and Marsden, 1988; Patel et al., 1988; Schmidt and Boshuizen, 1993; Schmidt et al., 1990) This is not a hypothetico-deductive model. Easy access to information makes it possible to make better and more accurate decisions because the direct automatic retrieval of information is representative of a more sophisticated decision making process (Bordage and Lemieux, 1991; Cantwell, 2004; Cholowski, 1998; Schmidt et al., 1990; Patel et al., 1990).

Summary of Students' and Midwives' Characteristics

In summary, the study characterised how student midwives make the transition from the first to their twentieth birth which represents the beginning of their professional practice. During this transition there was evidence of a qualitative shift in the students' modalities of thinking (that is, their level of understanding about normal birth). This change, which represents a change in their understanding, then influenced the change in their clinical practice.

The students (after their first birth) were less successful in decision making because of insufficient knowledge of the task and were therefore less likely to infer meaning from data cues. This often resulted in poor reasoning outcomes. Given the students' under-developed knowledge structure and limited experience with birthing an immature pattern of prior knowledge was predicted. Conversely, the students' knowledge (after their twentieth birth) had transformed into patterns or schemas of discipline specific knowledge used to reason care decisions with similar characteristics to those of experienced midwives. However, their knowledge structures and clinical decision making abilities were less sophisticated than those of midwives.

This thesis has put forward the argument that a range of factors influence the transformation of midwifery student knowledge structures, growth and development. The integration of declarative, procedural and conditional knowledge in the development of expertise is depicted in figure 6.1 which illustrates the evolution of students' knowledge and practice growth in an upward interactional spiral. The continuum of expertise is organised into three sequential sections. The vertical dimensions signify the beginnings of professional practice. Each loop of the interactional spiral represents the theoretical types of knowledge in the continuum of learning. The stages of practice and performance are on the left of the spiral and the right of the spiral depicts the terms that describe the process of framing and re-framing of knowledge, integrated with practice experiences, to achieve a level of expertise. The representations begin students' occupational identity shown at the bottom of the figure below.



Figure 6.1: Continuum of expertise

The horizontal items begin with the students' occupational identity, then their prior knowledge and understanding of the health care context as learning and practice begins. The body of midwifery declarative knowledge begins to structure with the procedural knowledge in the classroom laboratory. Practice at this level is dependent and promoted by a mentor or experienced peer, throughout the beginning of learning. Students' practice is

supervised throughout the course of learning. The students receive supportive cues with the task, in a cyclical and developing process, as they continue to master their skills. Each student develops individually in varying degrees related to their level of knowledge and practice development.

Knowledge transforms with practice experiences, common pieces of related information develop relationships and cluster together into networks of midwifery information. The knowledge networks structure initially into categories that consists of the woman, her foetus and infant, students' individual practice and the birth setting (defined in chapter three).

Throughout the learning process, framing and reframing of declarative knowledge with procedural knowledge become integrated by individuals' reflective practices and practice experiences. Their categorised midwifery knowledge of birth is transformed into understanding normal birth as a whole. With this transformed declarative and procedural knowledge the level of students' practice develops a degree of certainty and independence. By the end of the formal learning program and through practice their understanding of the when and why becomes more sophisticated in the development of conditional knowledge, as students employ discipline specific knowledge to reason. An individual's occupational identity begins with learning a new discipline, develops within this continuum of expertise and now advances into professional clinical practice.

The study findings identified that the midwifery students' declarative and procedural knowledge (after their twentieth birth) did resemble that of the experienced midwife. However, the students' conditional knowledge was in varying degrees of development, as were their decision making abilities and their discipline specific knowledge structures were not as sophisticated at this level of expertise.

The midwifery experts in the study were successful decision makers by employing sophisticated reasoning abilities from their readily assessable prior knowledge abstracted into a network of care schemas. Practice and knowledge were observed to be interdependent in a range of sophisticated abstract schemas of discipline specific knowledge.

Discipline specific knowledge incorporates individuals' declarative, procedural and conditional knowledge employed to make judgments and reason care decisions. It is the nature of an individual's practice discipline. The accumulation of declarative, procedural and

conditional knowledge, combined with years of experience in the discipline, reframes and restructures with each level and builds on the previous one through mentoring and self-reflective processes, critical thinking abilities and being metacognitive.

Knowledge and Expertise

The study found limited midwifery literature classifying how an individual's declarative, procedural and conditional knowledge develops and is structured, or its role in clinical decision making. Studies examining midwifery knowledge reported that in the midwifery literature identified the body of midwifery knowledge is centred on midwives' experiences and knowing women (Cioffi, 1997; Danerek and Dykes, 2001; Fleming, 1998; Tanner et al., 1993). The expert midwives have a 'bag of tricks' to reason (James et. al., 2003); or a framework of heuristics (Cioffi and Markham, 1997); often rely on a 'gut feeling' of the situation to reason (Orme and Maggs, 1993) while the use of this integrated knowledge and clinical practice experience allows their access to the problem as a whole, to facilitate rapid decision making (Cioffi, 1997; Danerek and Dykes, 2001); or the intuitive knowledge and experience in making clinical judgments and decisions (Hunter, 2007; Kelly, 1997; Mok and Stevens, 2005; Price and Price 1997; Siddiqui, 1994). These terms describe the types of reasoning strategies that rely on the individual's structured knowledge base and abstracted schema / s of discipline specific knowledge accounted for from this study's experienced midwives' reasoning strategy.

The study found that the key to expertise does not reside in merely gaining experience, as the midwifery literature would suggest, but in how the individual processes the learning experience (Ferry and Ross-Gordon, 1998). Learners develop the capacity to abstract or mentally represent problems as they acquire more context knowledge (Alexander and Judy, 1988) and to recognise these patterns as they encounter similar patient problems. If they do not recognise or understand the significance of clinical data it is on this basis that they cannot diagnose (Carnevali, 1984; Fonteyn, 1998).

The role of knowledge and experience in clinical decision making proficiency is an important component of clinicians' practice (Alexander, 1997; Benner, 1984; Benner et. al., 1996; Girot, 2000; Grobe et al., 1991, Lauri and Salanter, 1998). The more complex the clinical setting the more important it is for the midwife to have effective reasoning skills. Expert clinicians have effective reasoning skills because of their readily accessible and well-structured discipline specific knowledge and the capacity to access knowledge

effectively and efficiently to reason care decisions (Benner, 1984; Cholowski and Chan, 1995; Elstien et al., 1990; Narayan and Corcoran-Perry, 1997).

This study demonstrates that the expert midwife makes quality decisions throughout a birth. Decisions are often made in haste across a range of tasks. Birth tasks often preclude time to obtain assistance from other members of the team (Cioffi, 2002; McCaughan, 2002). Expert decision makers have the capacity to select, sort, cluster and assign value and meaning to data cues (Benner, 1984; Benner et al., 1996; Ericsson, 2003; Fine, 1997; Fonteyn, 1991; Pyles and Stern 1983; Tanner et al., 1987). They are able to think along multiple lines and different levels at the same time, make difficult judgements accurately, in a sophisticated decision making process (Cholowski, 1998).

Expertise takes time to develop, assisted by many years of experiences in the practice setting (Ashcraft, 2001; Simon, 1980). Through continually revisiting and restructuring to integrate new knowledge with old, each level of structured knowledge builds on the previous one (Rickers, Schmidt and Boshuizen, 2000). This position assumes learning knowledge and experience in an on-going cumulative collective (Fine, 1997).

The link between knowledge and experience has been mentioned in the literature by Benner, the National Competency Standards for the Midwife, and studies of medical clinicians' decision making. On the question of how much knowledge and practice makes the expert, Simon (1980) says it may not be years of experience that develops as expertise, even though it might take up to ten years of experience in a discipline to achieve. Engagement in learning of midwifery knowledge and sharing stories, shape the development of midwives' personal knowledge. Formal books and journals provide the opportunities for the continual advancement of knowledge and expertise (Ambler, 1995; Cioffi, 1998; Fine, 1997; Greener, 1988; Higgs and Titchen, 2000; Price and Price, 1997). The experienced midwives in the study had an average of 16 years of experience birthing women. They demonstrated advanced practice expertise and competence, made valid and reliably accurate judgments with little effort and greater accuracy, and were metacognitively aware. It was important to the midwives that they shared knowledge and practice skills with others, by being a mentor / preceptor and role model. For example an experienced midwife was the preceptor who shared her knowledge and skills for Kate's first birth task.

The integration of knowledge and past experiences is synthesised into schemas of abstracted discipline specific knowledge by returning to the experience and actively

reflecting on the elements and outcomes of their actions (Boud and Walker, 1990). This deep approach to transforming knowledge is facilitated by placing meaning on knowledge in such a way that the knowledge concepts and practice knowledge relate (Schon, 1997). To place an argument, structure and apply knowledge to practice, test and reframe the knowledge against the clinical data cues, and recognise uncertainties within data while maintaining the ability to synthesise this new knowledge into practice. An individual's long term memory has the ability to hold vast amounts of networked knowledge in abstract form and its capacity is immeasurable.

This study demonstrated that experienced midwives had access to a well-structured quality discipline specific knowledge base of network abstracted care schemas. These abstract schemas of discipline specific knowledge are the cognitive strategies that assist the expert's sophisticated decisions, made with confidence and accuracy. This readily accessible and discipline specific knowledge is the connection to sophisticated decision making skills by the expert.

The final parts of the chapter discuss the implications of the study findings, which involve midwifery education and practice; the study's coding scheme and the adaptability of the findings for all health professionals; and provide recommendations for future studies.

Implications for Midwifery Education

The outcome of the study provides important information on the acquisition of a discipline specific knowledge. Firstly, it does this by demonstrating how students' knowledge structures and their clinical decision making develop from beginning student through to a beginning midwife. Secondly, the study demonstrated the use of experienced midwives' discipline specific knowledge in clinical decision making. These two themes are discussed in relation to learning and teaching, respectively.

The critical link between learning and the development of a well-structured discipline specific knowledge base is the practice of self-regulatory awareness because the formation of an individual's knowledge structure cannot be taught (Benner and Tanner, 1987). However self-regulatory practices will facilitate the structure of knowledge growth. This reflective captivity facilitates changes in thinking about previously held assumptions, or a perspective transformation occurs by reflecting on their learning and practice knowledge application. For a midwifery program the adoption of a formalised strategy of self-regulatory

monitoring for students by a clinical mentor or experienced peer, and formal clinical practice supervision is recommended (Duerden, 2005; Forneris and Peden-McAlpine, 2006; Hicks et al., 2003; Licqurish and Seibol, 2008; Tanner, 2006).

A mentor formalises the learning process by assisting the learner to develop techniques that strengthen their own resources and independent thinking. The constructive use of questioning to guide thinking infers that exposing students to experts' experience and covert thinking processes emphasises a gradual transfer of relevant self-regulatory or metacognitive strategies from the mentor to student (Volet, 1991). Learners then develop critical thinking ability as they begin to construct their discipline specific knowledge.

While their declarative knowledge in the form of lectures are given and accessed in a classroom or online, the mastery of students' mandatory midwifery clinical skills (procedural knowledge) is supervised and subsequently assessed in the practice setting. It is in this practice setting where the integration of knowledge with practice benefits from the guidance of an experienced mentor throughout the program. Knowledge structures do not necessarily change and develop with practice/experience. To ensure that students do develop the appropriate standard of practice the mentor provides guidance in reflection. For example, by asking the student what is known about the skill or knowledge concept; then asking them to describe and monitor any known risks related to the skill or concept; and hypothesise a desired outcome. The mentor develops this type of framework with the student to reflect on their practice. The process continues until the student is familiar with it and is able to reflect independently. To make sure that knowledge is transferred and is integrated follow up supervision is required. This challenge to the student's prior knowledge and experience results in a personal transformation of a more sophisticated knowledge and practice perspective of their conditional knowledge.

This self-regulatory inquiry for students under the guidance of a mentor involves metacognitive strategies, affective learning and thinking, cognitive task knowledge and most importantly having an understanding of one's strengths and weaknesses and being adaptable to change (Pintrich, 2002; Schraw, 1998). Without this opportunity to develop critical thinking competence, the integration of knowledge and practice may be limited, and decision making and practice would have an overemphasis on factual knowledge and the rote skills of a task, and which may result in less sophisticated practice development.

In the transition from student to midwife, the newly accredited midwife would benefit from a formalised graduate midwifery program to assist in the on-going development of their knowledge and professional practice as they establish an occupational identity. Such a program will develop the graduates' decision making capability which had limited time to develop during their supervised practice as a student. The program also involves 'clinical practice supervision', which focuses on the development of their professional practice skills and broadens discipline specific knowledge over the multiple domains of the discipline (Driscoll, 2007; Schraw, 1998).

In the acquisition of a discipline specific knowledge the teaching role of experienced midwives in modelling and coaching of the metacognitive strategies for the students, is the second theme discussed. Introducing opportunities to develop or improve the formal self-regulatory techniques and clinical practice supervision skills of experienced midwives / clinical mentors would ensure their commitment and enhance their motivation. The mentor's competence to teach and their personal development are associated with the developmental processes of learning to assist in understanding the mentee's learning. The modelling and coaching of content relevant metacognitive strategies in an academic course should not be taught in the discipline context. Relevant discipline specific strategies avoid errors in thinking (Croskerry, 2000; Glaser 1984; Schraw, 1998; Volet, 1991). The gradual transfer of relevant discipline specific knowledge, based in the practice setting, promotes the transfer of metacognitive strategies from the mentor to mentee.

Midwives' advanced levels of practice and critical thinking abilities are necessary in the uncertain environment surrounding labour and birth. Midwifery authors have described midwives as committed to life-long learning, being self-aware and critically reflective in their practice (Hansom and Butler, 2003; Homer, Passant, Brodie, Kildea, Leap, Pincombe, and Thorogood, 2009; Kelly, 1997; Nakielski, 2005; Siddiqui 1994). The critical thinking midwife knows when, where and how to act independently (Kelly, 1997; Price, 1995). Glaser and Chi (1988) described the self-regulatory capacity of experienced midwives employed high levels of metacognition in the reasoning process.

A further implication for midwifery education from the findings is to provide insights into how the expert midwives think about their practice, and to highlight their discipline specific knowledge. It showed how experienced midwives' made successful care decisions with their abstract schema / s of discipline specific knowledge and provided some scaffolds for their thinking. The use of clinical scenarios from the 'real world' of practice could be used to

form a series of flow chart options, from simple to complex, for student learners to make care decisions and improve their decision making skill. This learning strategy makes use of students' prior knowledge to critically think and reason to make decisions, which mimics the reality of practice under guidance in a classroom setting. Staging learning in this manner benefits transformation of new knowledge and strengthens its future application in practice. The outcomes from the study findings show how a student's knowledge develops and offers an opportunity to evaluate programs to incorporate a metacognitive approach to midwifery education. It can also be incorporated into other health professionals' curriculum designs.

Application of the Study Findings

The purpose of the study was to examine student knowledge growth in clinical decision making when performing their first and twentieth normal birth tasks and to compare this with that of experienced midwives. The study's context and task were in the recall of a 'real world' clinical experience. The environment provided students with a complete understanding of learning in the clinical setting and of its dynamics. This direct experience with patients in the practice setting was identified as a catalyst in knowledge integration. The nature of every birth is unique and the students' and midwives' decision making is guided by women's individual needs and involving the safety of her and her baby.

This practice setting is not unique and is shared by many students, midwives and other health professionals. Therefore the degree of interest in the findings is not restricted to midwifery students and midwives. The findings will represent some reality outside the subject population sample of student and experienced midwives or a setting wider than this study. While the study is essentially context-bound it does provide insight into how students' knowledge develops during the course of a program. The study's design plan was a qualitative approach with elements of quantitative analysis. The rich data provided insights that may not have been possible with a different type of design.

Data were reliable and valid and findings were generalised because the study did unravel the complexities of knowledge transformation, and the students' knowledge development and its relationship with practice experiences. The structure of students' knowledge was explained using the midwifery competency standards, Benner's proficiency practice levels, the characteristics of Cantwell's knowledge acquisition model, and the midwifery and health professionals' literature (Table 3.1) (ANMC, 2006; Benner, 1984; Biggs and Collis, 1989; Cantwell, 2004). As a result, the contents of this theoretical framework provided the format

to unpack the transformation and structure of midwifery students' knowledge development and to represent the experienced midwives' discipline specific knowledge. This theoretical framework can provide an explanatory theory for the wider population of health care disciplines to understand students' knowledge growth in clinical decision making.

The Coding Scheme Design

Students' and midwives' data were coded into the verbal segments and each segment then further coded and given a measure of its relevance. The study's coding scheme successfully identified the quantity and quality of students' and midwives' knowledge, specifically the students' knowledge growth from their first to the twentieth birth.

The study's coding scheme with its three major categories and subcategories have operational definitions to uphold coding decisions and rule out the possibility of any ambiguity or inconsistency. The methodological design of the scheme linked the knowledge, skill and attitude; the declarative, procedural and conditional types of knowledge, and the coding scheme's history, action and rationalise codes. They were interconnected in a framework to explain the what, how and why of professional practice (illustrated in chapter four, figure 4.3).

The complex coding scheme was validated by its effectiveness and unambiguous comparison of students' and midwives' data. The opportunity to use this scheme in future studies is encouraging because it was effective in classifying and measuring the types of students' and experienced midwives' knowledge. An important feature of the findings was the relationship between quantity and quality of students' and midwives' knowledge in their clinical decision making process. Therefore it would be useful in similar clinical studies across different discipline groups at various levels of experience.

The study's findings give rise to a number of questions to explore in further research.

Recommendations for Future Research

The study findings have identified three opportunities for further research. Those recommended involve the students beginning practice; the experienced midwives' discipline specific knowledge development; and the knowledge development of beginning midwives in relation to expert midwives.

The midwifery practice setting is often confusing and disjointed for students (Clarke, 2002). The students, at the beginning their midwifery program, were new to the discipline in an unfamiliar practice setting when performing their first birth. The study highlighted that this caused the beginning students to be uncertain with their declarative knowledge and often anxious using their procedural knowledge as they search memory for prior knowledge. Their prior knowledge consisted of information gained from formal lectures, classroom practice in the technique and observation of five normal births in the practice setting. Benner (1984) found this anxiety causes beginners to develop a detachment from the task, an inability to reason and make care decisions, which created for them a sense of the unreal in the situation.

These concerns recommend further examination of students at the commencement of practice to focus on the students' experiences at their beginning practice. The aim would be to provide students with the strategies to enable their transition from beginning to learn in this unfamiliar practice environment and to minimise any possible anxiety.

The experienced midwives in the study all had many years' practical experience birthing woman, with hospital based midwifery qualifications and a few had specialist tertiary qualifications. The study has established that the experienced midwives were experts in practice and their discipline specific knowledge consisted of accessible abstract schemas of care options used to reason their decisions. From this finding the question emerges: how do experienced midwives structure their abstract schemas of discipline specific knowledge?

The study systematically clarified students' knowledge development, identifying schemas or patterns of integration discipline specific knowledge at the level of beginning midwifery practice. It did not purposely examine the knowledge development of beginning midwives' practice to expert midwives' practice at the same level of sophistication. There is a gap in the understanding of knowledge growth from graduate midwife to expert midwife. Therefore, future studies maybe beneficial to examine how prior knowledge develops with practice, to identify the stages of practice expertise and to support its development. To unravel the complexities of knowledge and practice development will reveal insights into the professional practice of the expert midwife.

Conclusion

Discipline specific knowledge and sound clinical judgment in advanced problem solving expertise, together with higher-order thinking abilities, are the qualities of a professional midwife. These qualities cannot be overstated when assisting women to birth.

This thesis provided insight into the structure of student midwives' knowledge when performing their first and their twentieth birth, and identified the knowledge structure of experienced midwives when making clinical decisions while performing a normal birth. The clinical decision making of experienced and student midwives may be explained on the basis of a knowledge driven model. The knowledge students used to reason had transformed from fragmented loosely constructed declarative knowledge and weaker knowledge associations in their first birth, to integrated schemas of discipline specific knowledge and care decisions by the twentieth birth.

The students' learning was not a linear process, but a complex integration of knowledge and experiences that structure into schemas of discipline specific knowledge. A discipline specific knowledge base develops from declarative knowledge, as a structured collection of facts. The integration of declarative knowledge with procedural knowledge, clinical practice skills and techniques, continually evolves with practice experiences. During a qualitative shift in thinking knowledge becomes structured to form links and relationships between facts, the task itself and patterns of specific clinical practice outcomes. Conditional knowledge employed to make judgments and reason decisions by knowing when and why to apply declarative and procedural knowledge is the nature of an individual's practice discipline.

The less experienced student could only draw on a less structured and less accessible discipline specific knowledge base, resulting in lower quality and less comprehensive decision making. On the other hand the students after their twentieth birth showed similar characteristics to those of the experienced midwives however their knowledge structure and decision making ability was less sophisticated. The findings are consistent with Schmidt's (1993) contention that while prior knowledge is the most important determinant of the amount of new information that can be processed, it cannot be used to reason and make decisions before the individual has learned to structure that knowledge to respond to practice situations.

The experienced midwives drew on a readily accessible and more highly structured discipline specific knowledge base of networked abstract care schemas. These abstract schemas of discipline specific knowledge are the cognitive strategies that assist the expert's sophisticated decisions to be made with confidence and accuracy.

Even though the study explained how the experienced midwives' sophisticated discipline specific knowledge was used in their decision making, it did not show how knowledge continues to develop from beginning practice to expertise in midwifery practice. Therefore an inquiry is recommended to explore how the beginning graduate midwives' knowledge is structured through the stages of practice expertise as they develop their professional practice.

The implication of the findings for midwifery education is the conceptual process of self-regulation and evaluation to enhance the students' learning in the practice environment. The incorporation of self-regulated (metacognitive) strategies and self-evaluation facilitates greater flexibility in the control of that development because metacognitively aware learners are more strategic and perform better than metacognitively unaware learners (Biggs, 1985; Schraw and Moshman, 1995).

An important component in the study's design was the examination of knowledge growth and development in the decision making in a 'real time' clinical practice. This real time inquiry of students and midwives' direct experience with patients in practice contributes to a more complete understanding of their cognitions as they recalled actual thinking and doing throughout the task. In this environment, the practice variables for example, the time pressures of the chronology of birth, the stress of learning the task (for students) and dealing with adverse events, and communication with others were identified. The environment did provide valid real time decision making experiences for the students and midwives. The students and midwives were able to say what they did do in this situation rather than what thought they might do in an experimental situation. There were limited clinical studies, examined for this research, which used real time clinical situations. Those studies tended to focus on experiments based on simulations in the form of case scenarios / studies, or with trained actors to simulate a patient. Few studies considered the structural development of an individual's knowledge during direct experience with patients in practice.

Cognitive and metacognitive knowledge, practice ability and personal knowledge are incorporated within the four domains of the *National Competency Standards for the Midwife*

(ANMC, 2006). The Standards describe the qualities of the professional midwife, cover the broader multiples of a midwife's discipline specific knowledge and provide benchmarks that account for midwives' competent practices.

Throughout this thesis, attention has been drawn to the role of knowledge and practice integration impacting on the students' and midwives' decision making capabilities, and how these experiences influenced the transitional process of the student towards becoming a midwife. An argument has been built that the transition to midwife status involves the development of a structured discipline specific knowledge base, coupled with the development of higher-order thinking abilities and continuing levels of practice competence. The development of these qualities represents significant contributions to our understanding of the way in which cognitive and metacognitive knowledge are able to interact in the process of learning. Therefore the findings of this thesis have made a significant contribution to our understanding of the scaffolds inherent in the knowledge growth and decision making of students and midwives within the practice discipline of midwifery.

Reference List

- Adams, A., Pelletier, D., Duffield, C., Nagy, S., Crisp, J., Mitten-Lewis, S., Murphy, J. (1997). Determining and discerning expert practice: a review of the literature. *Clinical Nurse Specialist* 11(5), 217-222.
- Aitken, R. L., Faulkner, R., Bucknal, T. and Parker, J. (2002). Aspects of nursing education: The types of skills and knowledge required to meet the changing needs of the labour force involved in nursing. Literature Reviews. *National Review of Nursing Education*. DEST publications.
<http://www.dest.gov.au/highered/nursing/pubs/midwifery/1.htm>
- Alexander, C. (1997). Influencing decision making. *Nursing Standard*, 11(38), 39-44.
- Alexander, P. A. (1992). Domain knowledge: evolving themes and emerging concerns. *Educational Psychologist*, 27(1), 33-51.
- Alexander, P. A. (1996). The past, present, and future of knowledge research: A re-examination of the role of knowledge in learning and instruction. *Educational Psychologist*, 31(2), 89-92.
- Alexander, P. A. and Judy, J.E. (1988). The interaction of domain-specific and strategic knowledge in academic performance. *Review of Education Research*, 58, 375-404.
- Ambler, N. (1995). *The role of a midwife: A comparative study of women's and midwives perceptions*. Unpublished master's dissertation, University of Technology, Sydney.
- Arocha, J.E., Patel, V.L. and Patel, Y.C. (1993). Hypothesis generation and the coordination of theory and evidence in novice diagnostic reasoning. *Medical Decision Making* 13, 198-211.
- Ashcraft, A. L. S. (2001). *The clinical reasoning of expert acute care registered nurses in pre-cardiopulmonary arrest events*. Unpublished doctoral dissertation, The University of Texas, Austin.
- Atkins, S. and Murphy, K. (1993). Reflection: a review of the literature. *Journal of Advanced Nursing* 18, 1188-1192.
- Australian College of Midwives. (1998). *Australian College of Midwives Incorporated Competency Standards for Midwives*. Melbourne: ACMI.
- Australian Health Workforce Advisory Committee. (2002). *The Midwifery Workforce In Australia, AHWAC Report 2002.2*, Sydney: AHWAC.
- Australian Nursing and Midwifery Council (2005). *National Competency Standards for the Midwife*. Canberra: ANMC.
- Australian Nursing and Midwifery Council (2006). *Australian Nursing and Midwifery Council National Competency Standards for the Midwife*. Canberra: ANMC.

Australian Nursing and Midwifery Council (2007). A National Framework for the Development of Decision-Making Tools for Nursing and Midwifery Practice. Canberra: ANMC.

Azzarello, J. (2003). Knowledge structure and problem solving: How do novice and expert home care nurses compare? *Southern Online Journal of Nursing Research*, 4(2), 1-26.

Bainbridge, L. (1979). Verbal reports as evidence of the process operator's knowledge. *International Journal Man – Machine Studies*, 11, 411-436.

Bainbridge, L. (1999). Verbal reports as evidence of the process operator's knowledge. *International Journal of Human – Computer Studies*, 51(2), 213-238.

Balla, J., Biggs, J., Gibson, M. and Chang, A. (1990). The application of basic science concepts to clinical problem solving. *Medical Education*, 24(2), 137-147.

Barclay, L. (1989). What are the origins of the regulations, training and practice of midwifery in Australia. Proceedings of the sixth biennial conference of the Australian College of Midwives Incorporated: Darwin, Northern Territory: ACMI.

Barclay, L. (2007). A feminist history of Australian midwifery from colonisation until the 1980s. *Women and Birth*, 21, 3-8.

Barrows, H.S. and Feltovich, P. J. (1987). The clinical reasoning process. *Medical Education* 21, 86-91.

Beischer, N. A. and Mackay, E. V. (1988). *Obstetrics and the Newborn* (2nd Ed.) Sydney: W.B.Saunders Company.

Benner, P. (1984). *From Novice to Expert: excellence and power in clinical nursing practice*. California: Addison-Wesley.

Benner, P. (2004). Designing formal classification systems to better articulate knowledge, skills, and meanings in nursing practice. *American Journal of Critical Care*, 13(5), 426-430.

Benner, P. and Tanner, C. (1987). Clinical judgment: how expert nurses use intuition. *American Journal of Nursing*, (January), 23–31.

Benner, P., Hooper-Kyriakidis, P. and Stannard, D. (1999). *Clinical wisdom and interventions in critical care*. Sydney: W.B. Saunders Company.

Benner, P., Tanner, C. and Chesla, C. (1992 March). From beginner to expert: gaining a differentiated clinical world in critical care nursing. *Advances in Nursing Science*, 13-28.

Benner, P, Tanner, C. and Chesla, C. (1996). *Expertise in Nursing Practice, Caring, Clinical Judgement and Ethics*. New York: Springer Publishing Company.

Bennett, V. R. and Brown, L. K. (Eds.) (1999). *Myles textbook for Midwives* (13th Ed.) London: Churchill Livingstone.

Biggs, J.B. (1988). The role of metacognition in enhancing learning. *Australian Journal of Education*, 32, 127-138.

- Biggs, J. (1999). *Teaching for Quality Learning at University*. Buckingham, United Kingdom: The Society for Research into Higher Education and Open University Press.
- Biggs, J.B. and Collis, K.F. (1982). *Evaluating the Quality of Learning: The SOLO taxonomy*. New York: Academic Press.
- Biggs, J.B. and Collis, K.F. (1989). Towards a model of school-based curriculum development and assessment using the SOLO taxonomy. *Australian Journal of Education*, 33, 151–163.
- Biggs, J. B. and Telfer, R. (1987). *The Process of Learning*. Sydney: Prentice-Hall.
- Bjark, I. (1997). Changing conceptions of practical skill and skill acquisition in nursing education. *Nursing Inquiry*, 4 (3) 184-195.
- Bland, M. (2000). *An Introduction to Medical Statistics*, (3rd Ed.) Oxford UK: Oxford University Press.
- Bordage, G. (1994). Elaborated knowledge a key to successful diagnostic thinking. *Academic Medicine*, 69, 883-885.
- Bordage, G. and Lemieux, M. (1991). Semantic structures and diagnostic thinking of experts and novices. *Academic Medicine*, 66, 570-572.
- Bordage, G., Gale-Grant, J. and Marsden, P. (1990). Quantitative assessment of diagnostic ability. *Medical Education*, 24, 413-425.
- Boshuizen, H.B.A. and Schmidt, H.G. (1992). On the role of biomedical knowledge in clinical reasoning by experts, intermediates and novices. *Cognitive Science*, 16, 153-184.
- Boshuizen, H.B.A. and Schmidt, H.G. (2000). The development of clinical reasoning expertise. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp.15-23) Sydney: Butterworth Heinemann.
- Boshuizen, H.B.A. and Schmidt, H.G., Custers, E.J.F.M. and van den Wiel, M. W. (1995). Knowledge development and restructuring in the domain of medicine: The role of theory and practice. *Learning and Instruction*, 5, 269-286.
- Boud, D. and Walker, D. (1990). Making the most of experience. *Studies on Continuing Education*, 12(2), 61-80.
- Boyd, C. and Sellers, L. (1982). *The British Way of Birth*. London: Pan.
- Brodie, P. and Barclay, L. (2001). Contemporary issues in Australian midwifery regulation. *Australian Health Review*, 24(4). 113-118.
- Bucknall, T.K. (2000). Critical care nurses' decision-making activities in the natural clinical setting. *Journal of Clinical Nursing*, 9, 25-36.
- Burns, R. (1994). *Introduction to research methods* (2nd Ed.) Sydney: Longman.

Cahill, M. and Fonteyn, M. (2000). Using mind mapping to improve students' metacognition. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp 214-221) Sydney: Butterworth Heinemann.

Cameron-Traub, E, (1995). Clinical, conceptual and empirical aspects of nursing practice. In G. Gray and R Pratt (Eds.). *Scholarship in the discipline of Nursing* (pp. 31-50) Sydney: Churchill Livingstone.

Cantwell, R.H. (2004). Positioning the bar: Outcomes associated with successful completion of an enabling course. *Australian Journal of Adult Learning*, 44(3), 354-388.

Caputo, I. A. and Mior, S.A. (1998). The role of clinical experience and knowledge in clinical decision making. *Topics in Clinical Chiropractic*, 5(2), 10-18.

Carnevali, D. L. (1984). The diagnostic reasoning process. In D.L. Carnevali, P.H. Mitchell, N.F.Woods and C.A.Tanner (Eds.) *Diagnostic reasoning in nursing*. Philadelphia: Lippincott.

Carnevali, D. L. (2000). Self-monitoring of clinical reasoning. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp 166-173) Sydney: Butterworth Heinemann.

Carr, J., Jones, M. and Higgs, J. (2000). Learning reasoning in physiotherapy programs. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession* (2nd Ed.) (pp. 198-204) Sydney: Butterworth Heinemann.

Cervero, R.M. (1992). Professional practice, learning, and continuing education: an integrated perspective. *International Journal of Lifelong Education*, 10, 91-101.

Chan, C., Tsui, M.S., Chan, M. and Hong, J. (2002). Apply the structure of the observed learning outcomes (SOLO) taxonomy on student's learning outcomes: an empirical study. *Assessment and Evaluation in Higher Education*, 27(6), 511-27.

Chartier, I. (2001). Use of metacognition in developing diagnostic reasoning skill of novice nurses. *Nursing Diagnosis*, 12(2), 55-60.

Chi, M.T.H., Feltovich, P.J. and Glaser, R. (1981). Categorisation and representation of physics problem by experts and novices. *Cognitive Science*, 5, 121-152.

Chi, M.T.H., Glaser, R. and Farr, M.J. (1988). *The Nature of Expertise*. New Jersey: Lawrence Erlbaum Associates, Inc.

Cholowski, K.M. (1998). *Prior knowledge and diagnostic reasoning processes in clinical problem solving by experience and student nurses*. Unpublished doctoral dissertation, The University of Newcastle, Australia.

Cholowski, K.M and Chan, L.K.S. (1995). Knowledge-driven problem solving models in nursing education. *Journal of Nursing Education*, 34, 148-154.

Cholowski, K. M. and Chan, L. K. S. (2004). Cognitive factors in student nurses' clinical problem solving. *Journal of Evaluation in Clinical Practice*, 10(1), 85–95.

- Cioffi, J. (1997). Heuristics, servants to intuition, in clinical decision-making. *Journal of Advanced Nursing*, 26, 203-208.
- Cioffi, J. (1998). Education for clinical decision making in midwifery practice. *Midwifery*, 14, 18-22.
- Cioffi, J. (2000). Nurses' experiences of making decisions to call emergency assistance to their patients. *Journal of Advanced Nursing*, 32(1), 108-114.
- Cioffi, J. (2002). What are clinical judgements? In C. Thompson and D. Dowding (Eds.) *Clinical Decision Making and Judgement in Nursing* (pp. 47-66). Sydney: Churchill Livingstone.
- Cioffi, J. and Markham, R. (1997). Clinical decision-making by midwives: managing case complexity. *Journal of Advanced Nursing*, 25, 265-272.
- Cioffi, J., Purcal, N. and Arundell, F. (2005). A pilot study to investigate the effect of a simulation strategy on the clinical decision making of student midwives. *Journal of Nursing Education*, 44(3), 131-134.
- Clarke, H. (2002). A personal philosophy of midwifery. *British Journal of Midwifery*, 10(2), 84-87.
- Clegg, F. (1992). *Simple Statistics*. Sydney: Cambridge University Press.
- Cooke, P. (2005). Helping women to make their own decisions. In M. Raynor, J. E. Marshall and A. Sullivan (Eds.) *Decision making in midwifery practice* (pp. 127-142). London: Elsevier Churchill Livingstone.
- Corcoran, S.A. (1986a). Expert and novice nurses' use of knowledge to plan for pain control. *The Journal of Hospice Care* (November/December), 37-41.
- Corcoran, S.A. (1986b). Planning by experts and novice nurses in cases of varying complexity. *Research in Nursing & Health*, 9(2), 155-162.
- Corcoran-Perry, S. and Narayan, S. (2000). Teaching clinical reasoning in nursing. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp. 249-254) Sydney: Butterworth Heinemann.
- Croskerry, P. (2000). The cognitive imperative: thinking about how we think. *Academic Emergency Medicine*, 7(11), 1223-31.
- Crutcher, R. J. (1994). Telling us what we know: The use of verbal report methodologies in psychological research. *American Psychological Society*, 5(5), 241-244.
- Cust, J. (1995). Recent cognitive perspectives on learning – implications for nurse education. *Nurse Education Today*, 15, 280-290.
- Cust, J. (1996). A relational view of learning: implications for nurse education. *Nurse Education Today*, 16, 256-266.

- Custers, E.J.F.M., Boshuizen, H.B.A. and Schmidt, H.G. (1998). The role of illness scripts in the development of medical diagnostic expertise: results from interview study. *Cognition and Instruction*, 16(4), 367- 398.
- Cutts, D. (1995 a). Midwifery competencies – Draft 2. *Australian College of Midwives Incorporated Journal*, 8(3), 11-13.
- Cutts, D. (1995 b). Australian College of Midwives Incorporated Journal competencies – version three. *Australian College of Midwives Incorporated Journal*, 8(4), 21-25.
- Cutts D., David P.M., McIntyre M., Seibold C., Hopkins F. and Miller M. (2003). Werna Naloo – ‘We Us Together’: the birth of a midwifery education consortium. *Journal of Advanced Nursing*, 41(2), 179–186.
- Daley, B. (1999). Novice to expert: An exploration of how professionals learn. *Adult Education Quarterly*, 49(4), 133-148.
- Danerek, M. and Dykes, A.K. (2001). The meaning of problem solving in critical situations. *British Journal of Midwifery*, 9(3) 179–186.
- Davis, D. (1995). Ways of knowledge in midwifery. *Australian College of Midwives Incorporated Journal*, 9, 30-32.
- Davis, R. M. and Atkinson, P. (1991). Students of midwifery: ‘doing the obs’ and other coping strategies. *Midwifery*, 7, 113-121.
- Degazon, C. E. and Lunney, M. (1995). Clinical journal: A tool to foster critical thinking for advanced level of competence. *Clinical Nurse Specialist*, 9, 270-274.
- de Laine, M. (1997). *Ethnography: Theory and application in health research*. Sydney: MacLennan and Petty.
- de Jong, T. and Ferguson-Hessler, M. G. M. (1986). Cognitive structures of good and poor novice problem solvers in physics. *Journal of Educational Psychology*, 78(4), 279-288.
- de Jong, T. and Ferguson-Hessler, M. G. M. (1996). Types and Qualities of Knowledge. *Educational Psychology*, 31(2), 105-113.
- de Groot, A. D. (1965). *Thought and Choice in Chess*. The Hague: Mouton.
- de Vaus, D. A. (2001). *Research Design in Social Research*. London: Sage.
- Dornan, T., Boshuizen, H., King, N. and Scherpbier, A. (2007). Experience-based learning: a model linking the process and outcomes of medical students’ workplace learning. *Medical Education*, 41, 84-91.
doi:10.1111/j.1365-2929.2006.02652.x 13/11/2009
- Dowding, D. and Thompson, C. (2002). Decision making and judgement in nursing – some conclusions. In C. Thompson and D. Dowding (Eds.) *Clinical Decision Making and Judgement in Nursing* (pp. 183-192). Sydney: Churchill Livingstone.
- Driscoll, J. (2007). *Practicing Clinical Supervision, a reflective approach for healthcare professionals* (2nd Ed.). London; Elsevier Bailliere Tindall.

- Duerden, J. M. (2005). Supporting decision making through supervision. In M, Raynor, J. E. Marshall and A. Sullivan (Eds.) *Decision making in midwifery practice* (pp.157-168). London: Elsevier Churchill Livingstone.
- Easen, P. and Wilcockson, J. (1996). Intuition and rational decision-making in professional thinking: a false dichotomy. *Journal of Advanced Nursing*, 24, 667-673.
- Ellis, L. (2003). Illuminative case study design: a new approach to the evaluation of continuing professional education. *Nurse Researcher*, 10(3) 48-59.
- Ellis, P.A (1997). Process used by nurses to make decisions in the clinical practice setting. *Nurse Education Today*, 17, 325-332.
- Elstein, A. S. (1992). Paradigms for research on clinical reasoning: a researcher's commentary. *Teaching and Learning in Medicine*, 4(3), 147-149.
- Elstein, A. S. (2000). Clinical problem solving and decision making psychology: comment on "the epistemology of clinical reasoning". *Academic Medicine*, 75(10), s134-s136.
- Elstein, A.S. and Schwarz, A. (2000). Clinical reasoning in medicine. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp. 95-106) Sydney: Butterworth Heinemann.
- Elstein, A.S. and Schwarz, A. (2002). Clinical problem solving and diagnostic decision-making: selective review of the cognitive literature. *British Medical Journal*, 324, 729-732.
- Elstein, A.S., Shulman, L.S. and Sprafka, S. A. (1978). *Medical problem solving: An analysis of clinical reasoning*. Cambridge MA: Harvard University Press.
- Elstein, A.S., Shulman, L.S. and Sprafka, S. A. (1990). Medical problem solving: a ten year retrospective. *Evaluation and the Health Professions* 13(1), 5–36.
- Emden, C. (1991). Becoming a reflective practitioner. In G. Gray and R Pratt (Eds.). *Scholarship in the Discipline of Nursing* (pp. 335-354) Sydney: Churchill Livingstone.
- English, I. (1993). Intuition as a function of the expert nurse: a critique of Benner's novice to expert. *Journal of Advanced Nursing*, 18, 387-393.
- Ennis C.D., Cothran D.J. and Loftus S.L. (1997). The influence of teachers' educational beliefs on their knowledge organizations. *Journal of Research and Development in Education*, 30(2), 73-86.
- Ericsson, K.A. (2003). The acquisition of expert performance as problem solving: construction and modification of meditating mechanisms through deliberate practice. In J. E. Davidson and R. J. Sternbery (Eds.). *The Psychology of Problem Solving* (pp.31-38). Cambridge, UK: Cambridge University Press.
- Ericsson, K.A. (2007). An expert-performance perspective of research on medical expertise: the study of clinical performance. *Medical Education*, 4, 1124-1130.

Ericsson, K.A. and Charness, N. (1994). Expert performance: its structure and acquisition. *American Psychologist*, 49, 725-746.

Ericsson, K. A. and Crutcher, R. J. (1991). Introspection and verbal reports on cognitive process – two approaches to the study of thinking: A response to Howe. *New Ideas in Psychology*, 9(1) 57-71.

Ericsson, K. A. and Smith, J. (1991). *Towards a General Theory of Expertise: Prospects and Limits*. New York: Cambridge University Press.

Ericsson, K. A. and Simon, H. A. (1993). *Protocol Analysis Verbal Reports as Data* (2nd Ed.). Cambridge Mass: MIT Press.

Ertmer, P. A. and Newby, T. J. (1996). The expert learner: Strategic, self regulated and reflective. *Instructional Science*, 24, 1-24.

Eva, K.W., Brooks, L.R. and Norman, G.R. (2002). Forward reasoning as a hallmark of expertise in medicine: logical, psychological, phenomenological inconsistencies. *Advances in Psychology Research*, 8, 41-69.

Evans, D. and Patel, V. (1989). *Cognitive Science in Medicine*. Cambridge, MA: MIT Press.

Feltovich, P. and Barrows, H. (1984). Issues of generality in medical problem solving. In H Schmidt and M. De Volder (Eds.) *Tutorials in Problem-based Learning: A New Direction in Teaching Health Professionals* (p. 128-142) Assen: Van Gorcum.

Ferry, N. and Ross-Gordon, J. (1998). An inquiry into Schon's epistemology of practice: Exploring the links between experience and reflective practice. *Adult Education Quarterly*, 48(2), 98-112.

Fine, J. M. B. (1997). *A descriptive analysis of the clinical reasoning of expert labour and delivery nurses*. Unpublished doctoral dissertation, University of Texas, Austin.

Fisher, A. and Fonteyn, M. E. (1995). An exploration of an innovative methodological approach for examining nurses' heuristic use in clinical practice. *Scholarly Inquiry for Nursing Practice: An International Journal*, 9(3), 263-276.

Fleming, V. (1998). Women-with-midwives-with-women: a model of independence. *Midwifery*, 14, 137-45.

Fonteyn, M. (1998). *Thinking Strategies for Nursing Practice*. Philadelphia, PA: Lippincott.

Fonteyn, M. (1991). *A descriptive analysis of expert critical care nurses' clinical reasoning*. Austin, TX: University of Texas Press.

Fonteyn, M. E., Capers, B. and Grobe, S. J. (1993). A description of think aloud method and protocol analysis. *Qualitative Health Research*, 3(4), 430-441.

Forneris, S.G. and Peden-McAlpine, C.J. (2006). Contextual learning: a reflective learning intervention for nursing education. *International Journal of Nursing Education Scholarship*, 3(1), 1-18.

- Fowler, I. P. (1994). *Clinical reasoning of home health nurses: A verbal protocol analysis*. Unpublished doctoral dissertation, University of South Carolina, Columbia.
- Fowler, I. P. (1997). Clinical reasoning strategies used during care planning. *Clinical Nursing Research*, 6(4), 349-361.
- Fowler, C. and Lee, A. (2007). Knowing how to know: questioning 'knowledge transfer' as a model for knowing and learning in health. *Studies in Continuing Education*, 29(2), 181-193.
- Freeman, L. M. (2003). Influences on Midwifery practice for the management of women in labour. Unpublished doctoral dissertation, University of Auckland, New Zealand.
- Freeman, L. M., Adair, V., Timperley, H. and West, S. H. (2006). The influence of the birthplace and models of care on midwifery practice for the management of women in labour. *Women and Birth*, 19, 97-105.
- Gale, J. (1982). Some cognitive components of the diagnostic thinking process. *British Journal of Educational Psychology*, 52, 64-76.
- Gale, J. and Marsden, P. (1982). Clinical problem solving: the beginning of the process. *Medical Education*, 16, 22-26.
- Gall, M., Gall, J. and Borg, W. (2007). *Education Research: An Introduction* (8th Ed.) Boston: Pearson Education Inc.
- Giroit, E. A. (2000). Graduates nurses: critical thinkers or better decision makers? *Journal of Advanced Nursing*, 31(2), 288-297.
- Glaser, R. (1984). Education and thinking. *American Psychologist*, 39(2), 93-104.
- Glaser, R. (1991). The maturing of the relationship between the science of learning and cognition and educational practice. *Learning and Instruction*, 1, 129-144.
- Glaser, R. and Chi, R. (1988). Overview. In M.H. Chi, R. Glaser and M.J. Farr (Eds.) *The Nature of Expertise* (pp. xv-xxviii). Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Glover, P. (1991). *The development and validation of competencies for beginning midwifery practice - research report*. In proceedings of 7th Biennial Conference of the Australian College of Midwives Incorporated, Western Australia.
- Glover, P. (1993). The development and validation of competencies for beginning midwifery practice. Unpublished masters dissertation, University of South Australia, Adelaide.
- Glover, P. (1999 a). The midwifery curriculum – preparing beginning or advanced practitioners? *Australian Midwives College Incorporated Journal*, 12(1), 19-24.
- Glover, P. (1999 b). AMCI competency standards for midwives - what they mean for your practice. *Australian Midwives College Incorporated Journal*, 12(3), 12-17.
- Gordon, M. (1994). *Nursing diagnosis: Process and Application* (3rd Ed.) St. Louis, MO Mosby.

Gonczi, A. (1999). Competency-based learning, In D. Boud, and J Garrick (Eds) *Understanding Learning at Work*. London: Routledge.

Gonczi, A. (1994). Competency based assessment in the professions. *Australian Assessment in Education*, 1(1), 27-44.

Gonczi, A., Hagar, P. and Oliver, L. (1990). *Establishing Competency Based Standards in the Professions*. National Office of Overseas Skills Recognition Research Paper No. 1, Department of Employment, Education and Training, Canberra: Australian Government Publishing Service.

Gourgey, A. (1998). Metacognition in basic skills instruction. *Instructional Science*, 26, 81-96.

Graduate Diploma in Midwifery and Master of Midwifery studies (1995). *The University of Newcastle, Faculty of Nursing and Midwifery; curriculum document*, Printed and copyright at University of Newcastle: Australia.

Grant, G. and Marsden, P. (1987). The structure of memorised knowledge in students and clinicians: an explanation for diagnostic expertise. *Medical Education*, 21, 92-94.

Grant, G. and Marsden, P. (1988). Primary knowledge, medical education and consultant expertise. *Medical Education*, 22, 173-179.

Greener, D. (1988). Clinical judgement in nurse-midwifery. A review of the research with implications for education. *Journal of Nurse-Midwifery*, 33(6), 261-268.

Greenwood, J. (1998). Theoretical approaches to the study of nurses' clinical reasoning: getting things clear. *Contemporary Nurse*, 7, 110-116.

Greenwood, J. and King, M. (1995). Some surprising similarities in the clinical reasoning of 'expert' and 'novice' nurses: a report of a study using verbal protocols and protocol analysis. *Journal of Advanced Nursing*, 22(5), 907-913.

Grobe, S., Drew, J. and Fonteyn, M. (1991). A descriptive analysis of experienced nurses' clinical reasoning during a planning task. *Research in Nursing and Health*, 14, 305-314.

Groen, G.J. and Patel, V.L. (1985). Medical problem solving: some questionable assumptions. *Medical Education*, 19, 344-356.

Groen, G.J. and Patel, V.L. (1988). The relationship between comprehension and reasoning in medical expertise. In M. Chi, R. Glaser, and M. Farr (Eds.). *The Nature of Expertise* (pp 287-310) New Jersey: Lawrence Erlbaum Associates.

Grossman, S.C. and Wheeler, K. (1997). Predicting patient's deterioration and recovery. *Clinical Nursing Research*, 6, 45-58.

Hagar, P. and Butler, J. (1994). *Two Paradigms of Assessment*. Australia Association for Research in Education Conference abstracts <http://www.aare.edu.au> accessed 20/5/2008.

- Hamers, J.P.H., Huiger Abu-Saad, H. and Halfens, R.J.G. (1994). Diagnostic process and decision making in nursing: a literature review. *Journal of Professional Nursing*, 10(3), 154-163.
- Hammond, K. R. (1996). *Human Judgment and Social Policy*. New York: Oxford University Press Inc.
- Hanneman, S.K. (1996). Advancing nursing practice with a unit-based clinical expert. *Image – The Journal of Nursing Scholarship*, 28(4), 331-337.
- Hansom, J. and Butler, M. (2003). Sharing reflections in midwifery practice. *British Journal of Midwifery*, 11(1), 34-37.
- Hassebrock, F., Johnson, P. E., Bullemer, P., Fox, P. W. and Moller, J. (1993). When less is more: representation and selective memory in expert problem solving. *American Journal of Psychology*, 106(2), 155-189.
- Hassebrock, F. and Prietula, M. (1992). A protocol-based coding scheme for the analysis of medical reasoning. *International Journal Man-Machine Studies*, 37, 613-652.
- Heartfield, M. (2006). *Specialisation and Advanced Practice Discussion Paper*. Melbourne: National Nursing and Nursing Education Taskforce, pp. 1-36.
- Heath, P. (2002). *National Review of Nursing Education 2002: Our duty of care*. Canberra: Departments of Education, Science and Technology, and Health and Aging. ISBN 0642 773149.
- Hedberg, B. and Larsson, U. S. (2003). Observations, confirmations and strategies – useful tools in decision-making for nurses in practice. *Journal of Clinical Nursing*, 12, 215-222.
- Hicks, F.D., Merritt, S.L. and Elstein, A.S. (2003). Critical thinking and clinical decision making in critical care nursing: a pilot study. *Heart and Lung*, 32(2), 169-180.
- Higgs, J. (2004). Educational theory and principles related to learning clinical reasoning. In M. A. Jones and D.A. Rivett (Eds.), *Clinical Reasoning for Manual Therapists* (pp 379-402) Sydney: Butterworth Heinemann.
- Higgs, J. and Jones, M. (2000). Clinical reasoning in the health professions. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp. 3-14) Sydney: Butterworth Heinemann.
- Higgs, J. and Tichen, A. (2000). Knowledge and reasoning. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp. 23-32) Sydney: Butterworth Heinemann.
- Hoffman K, Aitken, L. and Duffield C. (2009). A comparison of novice and expert nurses' cue collection during clinical decision-making: verbal protocol analysis. *International Journal of Nursing Studies* [serial online].46(10):1335-1344. Available from: CINAHL Plus with Full Text, Ipswich, MA. Accessed 11/11/2009.
- Homer, C.S.E., Passant, L., Kildea, S., Pincombe, J., Thorogood, C., Leap, N. and Brodie, P. M. (2007). The development of national competency standards for the

midwife in Australia. *Midwifery*, 23, 350–360. www.elsevier.com/locate/midw Accessed 3/2/2008.

Homer, C.S.E., Passant, L., Brodie, P. M., Kildea, S., Leap, N., Pincombe, J. and Thorogood, C. (2009). The role of the midwife in Australia: views of women and midwives. *Midwifery*, 25, 673-681.
www.elsevier.com/locate/midw Accessed 9/7/2009.

Houston, M. and Weatherston, L. (1986). Creating change in midwifery: integrating theory and practice through practice-based research groups. *Midwifery*, 2(20) 65-70.

Hughes, K. and Young, K. (1992). Decision making stability of clinical decisions. *Nurse Educator*, 17(3), 12-16.

Hunter, L.P. (2007). A hermeneutic phenomenological analysis of midwives' ways of knowing during childbirth. *Midwifery*, Article in press, 1-16.

International Confederation of Midwives (2005). Definition of the Midwife. The Hague, Netherlands: International Confederation of Midwives.

Isenberg, D. J. (1986). Thinking and managing: A verbal protocol analysis of managerial problem solving. *Academy of Management Journal*, 29(4), 775-788.

Itano, J.K. (1989). A comparison of the clinical judgement process in experienced registered nurses and student nurse, *Journal of Nurse Education*, 28(3), 120-126.

James, D.C., Simpson, K.R. and Knox, G.E. (2003). How do expert labour nurses view their role? *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 32(6), 814-823.

Jenny, J. and Logan, J. (1992). Knowing the patient: one aspect of clinical knowledge. *Image - the Journal of Nursing Scholarship*, 24(4), 254-258.

Jerlock, M., Falk, K. and Severinsson, E. (2003). Academic nursing education guidelines: tool for bridging the gap between theory, research and practice. *Nursing and Health Sciences*. 5, 219–228.

Joseph G. and Patel, V. (1990). Domain knowledge and hypothesis generation in diagnostic reasoning, *Medical Decision Making*, 10, 31-46.

Kassirer, J. P. and Gorry, G. A. (1978). Clinical problem solving: a behavioural analysis. *Annals of Internal Medicine*, 89(2), 245-255.

Kassirer, J. P. and Kopelman, R. L. (1989). Learning clinical reasoning from examples. *Hospital Practice*, 27, 32-34, 44-45.

Kassirer, J. P. and Kopelman, R. L. (1991). *Learning Clinical Reasoning*. Baltimore: Williams and Wilkins.

Kaufman, D. and Patel, V. (1991). Problem solving in the clinical interview: a cognitive analysis of the performance of physicians, residents and students. *Teaching and Learning in Medicine*, 3(1), 6-14.

Keats, D. (1988). *Skilled Interviewing*. Victoria: Australian Council for Education Research Ltd.

- Kelly, M.E. (1997). Exploring midwifery knowledge. *British Journal of Midwifery*, 5 (4), 195-198.
- Kirkham, M. (2000). *The Midwife Mother Relationship*. London: McMillan Press.
- Kitzinger, S. (1998). *The Midwifery Challenge*. London: Pandora Press.
- Klein, G. (2003). *Intuition at Work*. New York: Currency Doubleday.
- Lane, K. (2002). Midwifery: a profession in transition. *Australian College of Midwives*, 15(2), 26-31.
- Larkin, J.H., McDermott, J., Simon, D.P. and Simon, H. A. (1980). Model of competence in solving physics problems. *Cognitive Science*, 4, 317-345.
- Lauri, S. and Salanterä, S. (1998). Decision-making models in different fields of nursing. *Research in Nursing and Health*, 21, 443-452.
- Leap, N. and Barclay, L. (2002). Midwifery Education: Literature Review and Additional Material. *National Review of Nursing Education*. Department of Education, Science and Technology publications.
<http://www.dest.gov.au/highered/nursing/pubs/midwifery/1.htm>
- Leap, N., Barclay, L., Nagy, E., Sheehan, A., Brodie, P. and Tracy, S. (2002). Midwifery Education: Literature Review and Additional Material. *National Review of Nursing Education*. Department of Education, Science and Technology publications.
<http://www.dest.gov.au/highered/nursing/pubs/midwifery/1.htm>
- Licqurish, S. and Seibold, C. (2008). Bachelor of midwifery students' experiences of achieving competencies: the role of midwife preceptor. *Midwife*, 24, 480-489.
www.elsevier.com/locate/midw Accessed 26/2/2009.
- Love, I. (1979). The history of midwifery training in Australia. *Proceedings of the National Midwives Association and R.N.F. Conference, Birth*. Adelaide, South Australia.
- Mander, R. (1989). Who continues? A preliminary examination of data on continuities of employment in midwifery. *Midwifery*, 5(1), 26-35.
- Mandin, H., Jones, A., Woloschuk, W. and Harasym, P. (1997). Helping students learn to think like experts when solving clinical problems. *Academic Medicine*, 72, 173-179.
- Marchant, S. (2005). Developing clinical judgments. In M, Raynor, J. E. Marshall and A, Sullivan (Eds.) *Decision making in midwifery practice* (pp. 85-100). London: Elsevier Churchill Livingstone.
- Masters, G. N. and McCurry, D. (1990). Competency-Based Assessment in the Professions. *National Office of Overseas Skills Recognition, Research Paper No. 2*. Canberra: Australian Government Publishing Service.
- May, K. A. and Mahlmeister, L. R. (1990). *Comprehensive Maternity Nursing* (2nd Ed.), Philadelphia: J. B. Lippincott Company.

McCaughan, D. 2002. What decisions do nurses make? In C. Thompson and D. Dowding (Eds.) *Clinical Decision Making and Judgement in Nursing* (pp. 95-108). Sydney: Churchill Livingstone.

McCrea, H., Thompson, K., Carswell, L. and Whittington, D. (1994). Student midwives' learning experiences on the wards. *Journal of Clinical Nursing*, 3, 97-102.

McMillan, J.H. and Schumacher, S. (2006). *Research in Education* (6th Ed.), New York: Pearson Education, Inc.

Meleis, A. (1985). *Theoretical nursing: development and process*. London: J.B. Lipponcott.

Mok, H. and Stevens, P. A. (2005). Models of decision making. In M. Raynor, J. E. Marshall and A. Sullivan (Eds.) *Decision Making in Midwifery Practice* (pp. 53-67). London: Elsevier Churchill Livingstone.

Nakielski, K.P. (2005). The reflective practitioner. In M, Raynor, J. E. Marshall and A, Sullivan (Eds.) *Decision Making in Midwifery Practice* (pp. 143-156). London: Elsevier Churchill Livingstone.

Narayan, S.M. and Corcoran-Perry, S. (1997). Line of reasoning as a representation of nurses' clinical decision making. *Research in Nursing*, 20, 353-364.

New South Wales Health, (1995). Midwifery circular: midwifery education. Sydney NSW: Nurses Registration Board.

New South Wales Health Midwifery Circular 1995/1 (1995). Midwifery Education Guidelines, Competencies and Essential Minimum Midwifery Experience, Sydney NSW: Nurses Registration Board.

New South Wales Midwives Association (RANF), (1984). *With Courage and Devotion, a History of Midwifery in New South Wales*. Marrickville: Southwood Press.

New South Wales Nurses and Midwives Board, (2007). Competency Standards Statement. Web address <http://www.nmb.gov.au - competency standards> accessed 5/11/2007.

New South Wales Nurses Registration Board. Circular No. MD 1990/1, (1990 July). Sydney NSW: Nurses Registration Board.

Newble, D., Norman, G. and van der Vleuten, C. (2000). *Assessing clinical reasoning*. In *Clinical Reasoning in the Health Profession* (2nd Ed.), Sydney: Butterworth Heinemann.

Newell, A. and Simon, H. (1972). *Human Problem Solving*. Englewood Cliffs, NJ: Prentice Hall.

Nightingale, F. (1860). *Notes on Nursing: what it is and what it is not*. Mineola, NY: Dover Press.

Norman, G. R., Brooks, L.R. and Allen, S. W. (1989). Recall by experts and novices as a record of processing attention. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 5, 1166-1174.

Oakley, A. (1989). Who cares for women. *Midwives Chronicle and Nursing Notes*, 214-221.

Offredy, M. (2002). How nurses use clinical information in practice. In C. Thompson and D. Dowding (Eds.) *Clinical Decision Making and Judgement in Nursing* (pp. 67-80). Sydney: Churchill Livingstone.

Oliver, M. and Butler, J. (2004). Contextualising the trajectory of experience of expert competent and novices nursing in making decisions and solving problems. *Collegian*, 11(1) 21-27.

Olds, S. B., London, M. L. and Ladewig, P. A. (1980). *Maternal-newborn Nursing: A family centred approach* (2nd Ed.) Sydney: Addison-Wesley Publishing Company.

Orme, L. and Maggs, C. (1993). Decision-making in clinical practice: how do expert nurses, midwives and health visitors make decisions? *Nurse Education Today*, 15, 270-276.

Patel, V. L. and Arocha, J. F. (2000). Methods in the study of clinical reasoning. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp. 78-94) Sydney: Butterworth Heinemann.

Patel V. L. and Groen G.J. (1986). Knowledge based solution strategies in medical reasoning. *Cognitive Science*, 10, 91-116.

Patel, V. L. and Groen, G. (1991). The general and specific nature of medical expertise: a critical look. In A. Ericsson and J. Smith (Eds.) *Towards a General Theory of Expertise: Prospects and Limits*. New York: Cambridge University Press.

Patel, V.L. and Kaufman, D.R. (2000). Clinical reasoning and biomedical knowledge: Implication for teaching. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession*, (2nd Ed.) (pp. 33-44) Sydney: Butterworth Heinemann.

Patel, V. L., Arocha, J. F. and Kaufman, D. R. (1994). Diagnostic reasoning and medical expertise. *The Psychology of Reasoning and Motivation*, 31, 187-252.

Patel, V. L., Evans, D. and Groen G.J. (1989). Reconciling basic science and clinical reasoning. *Teaching and Learning in Medicine*, 1(3), 116-121.

Patel, V. L., Groen, G. J. and Arocha, J. F, (1990). Medical expertise as a function of task difficulty reasoning and instruction in medical curricula. *Cognition and Instruction*, 10(4), 335-378.

Patel, V. L., Groen, G. J. and Norman, G. R. (1993). Reasoning and instruction in medical curricula. *Cognition and Instruction*, 10(4), 335-378.

Patel V. L., Groen G. J. and Scott, H. S. (1988). Biomedical knowledge in explanation of clinical problems by medical students. *Medical Education*, 22, 398-406.

Patel, V. L., Kaufman, D. R. and Arocha, J.F. (1999). Conceptual changes in biomedical and health sciences. R. Glasser (Ed.) *Advances in Instructional Psychology Vol. 5*, Hillsdale, NJ: Lawrence Erlbaum Associates.

PASW Statistics 17 for Windows, Release Version 17.0.0 (Ó SPSS, Inc., 2009, Chicago, IL, www.spss.com).

Peden-McAlpine, C. (2000). Early recognition of patient problems: A hermeneutic journey into understanding expert thinking nursing. *Scholarly Inquiry for Nursing Practice: An International Journal*, 14, 191-222.

Pintrich, P. (2002). The role of metacognitive knowledge in learning, teaching, and assessing. *Theory into Practice*, 41(4), 219- 226.

Posner, M.I. (1988). Introduction: what it means to be an expert? In M.H. Chi, R. Glasser, M.J. Farr (Eds.) *The Nature of Expertise* (pp.xxix-xxxvi). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Price, A. (1995). Sound choices: Part 2: developing decision-making skills. *Modern Midwifery*, 18-21.

Price, A. (2004). Encouraging reflections and critical thinking in practice. *Nursing Standard*, 18(47), 46-52.

Price, A. and Price, B. (1993). Midwifery knowledge: theory for action, theory for practice. *British Journal of Midwifery*, 1(5), 233 - 237.

Price, A. and Price, B. (1997). Making midwifery decisions. *Modern Midwifery*, 7(10), 15-19.

Putzier, D. J., Padrick, K., Westfall, U. E. and Tanner, C. A. (1985). Diagnostic reasoning in critical care nursing. *Heart and Lung*, 14(5), 430-435.

Pyles, S. H. and Stern, P. N. (1983). Discovery of nursing gestalt in critical care nursing: the importance of the gray gorilla syndrome. *Image: The Journal of Nursing Scholarship* 15(2), 51-57.

Radwin, L.E. (1995). Conceptualizations of decision making in nursing: Analytic models and "knowing the patient". *Nursing Diagnosis* 1, 16-22.

Raphael-Leff, J. (1991) *Psychological Processes of Childbearing*. London: Chapman and Hall.

Rew, I. (1990). Intuition in critical care nursing. *Dimensions of Critical Care Nursing*, 9(1), 30-38.

Rhodes, J. (1988). Integrating philosophy into the doctoral preparation for nurse-midwives. *Journal of Nurse-Midwifery*, 33(6) 283-284.

Rich, A. and Parker, D. (1995). Reflection and critical incident analysis: ethical and moral implications of their use within nursing and midwifery education. *Journal of Advanced Nursing*, 22, 1050 - 1057.

- Rikers, R. M. J. P., Schmidt, H. G. and Boshuizen, P.A. (2000). Knowledge encapsulation and the intermediate effect. *Contemporary Educational Psychology*, 25, 150-166.
- Rikers, R. M. J. P., Loyens, S. M. M. and Schmidt, H. G. (2004). The role of encapsulated knowledge in clinical case representations of medical students and family doctors. *Medical Education* 38: pp 1035-1043.
- Rivet, D.A. and Jones, M.A. (2004). Improving clinical reasoning in manual therapy. In M. A. Jones and D.A. Rivett (Eds.) *Clinical Reasoning for Manual Therapists* (pp 403-419) Sydney: Butterworth Heinemann.
- Russell, R., Gerthing, L. and Convery, P. (1997). *National Review of Specialist Nurse Education*. Department of Employment, Education, Training and Youth Affairs, Canberra: Australian Government Printing Service.
- Schon, D.A. (1987). *Educating the Reflective Practitioner. Towards a New Design for Teaching and Learning in the Professions*. California: Jossey-Bass Inc.
- Schmidt, H.G. and Boshuizen, P. A. (1993). On the origin of intermediate effects in clinical case recall. *Memory and Cognition*, 21(3) 338-351.
- Schmidt, H. G., Norman, G. R. and Boshuizen, P. A. (1990). A cognitive perspective on medical expertise: theory and implications. *Academic Medicine*, 65, 611-621.
- Schmidt, H. G. and Rikers, R. M. J. (2007). How expertise develops in medicine: knowledge encapsulation and illness scripts. *Medical Education*, 41, 1133- 1139.
- Scharder, B. and Fisher, D. (1987). Using intuitive knowledge in the neonatal intensive care nursery. *Holistic Nursing Practice*, 1(3), 45-51.
- School of Nursing and Midwifery, Flinders University, South Australia (2007) <http://www.nursing.flinders.edu.au> – undergraduate. Accessed 11/11/2007.
- Schraw, G. (1998). Promoting general metacognitive awareness. *Instructional Science*, 26, 113-125.
- Schraw, G. (2006). Knowledge: structure and processes. In P. A. Alexander and P. H. Winne (Eds.) *Handbook of Educational Psychology* (2nd Ed.) (pp 245-263). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Schraw, G. and Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review*, 7(4), 351 – 371.
- Seibold, C. (2005). The experiences of a first cohort of bachelor of midwifery students, Victoria, Australia. *Australian Midwifery Journal*, 18(3), 9-16.
- Shaw, R. (2001). Intuition in midwifery care. *Midwifery Matters*, 20-21.
- Siddiqui, J. (1994). A philosophical exploration of midwifery knowledge. *British Journal of Midwifery*, 2(9), 419- 422.
- Siddiqui, J. (2005). The role of knowledge in midwifery decision making. In M, Raynor, J. E. Marshall and A. Sullivan (Eds.) *Decision Making in Midwifery Practice* (pp. 23-36). London: Elsevier Churchill Livingstone.

- Simon, H.A. (1980). Problem solving and education. In D. T. Tuma and F. Reif (Eds.), *Problem Solving and Education Issues in Teaching and Research*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Stake, R. E. (1994). Case studies. In N.K. Denzin and Y.S. Lincoln (Eds.) *Handbook of Qualitative Research*. Thousand Oaks: Sage.
- Stake, R. E. (1995). *The Art of Case Study Research*. London: Sage
- Sutton, F. and Smith, C. (1995) Advanced nursing practice: different ways of knowing. In G. Gray and R. Pratt (Eds.) *Scholarship in the Discipline of Nursing* (pp. 133-145) Melbourne: Churchill Livingstone.
- Sullivan, A. (2005). Skilled decision making: the 'blood supply' of midwifery practice. In M. Raynor, J. E. Marshall and A. Sullivan (Eds.) *Decision Making in Midwifery Practice* (pp. 169-176). London: Elsevier Churchill Livingstone.
- Tanner, C. (1998). Clinical judgement and evidence-based practice: conclusions and controversies. *Communicating Nursing Research*, 31, 19-35.
- Tanner, C. (2006). Thinking like a nurse: a research based model of clinical judgement in nursing. *Journal of Nurse Education*, 45(6), 204-211.
- Tanner, C. A., Benner, P., Chesla, C. and Gordon, D.R. (1993). The phenomenology of knowing the patient. *Journal Nursing Scholarship*, 25(4), 275-80.
- Tanner, C., Padrick, K., Westfall, U. and Putzier, D. (1987). Diagnostic reasoning strategies of nurses and nursing students. *Nursing Research*, 36(6), 358-363.
- Thompson, C.D. (1999). A conceptual treadmill: the need for 'middle ground' in clinical decision making theory in nursing. *Journal of Advanced Nursing*, 30(5), 1222-1229.
- Thompson, C. D. and Dowding, D. (2002). Decision making and judgements in nursing – an introduction. In C. D. Thompson and D. Dowding (Eds.) *Clinical Decision Making and Judgement in Nursing* (pp. 1-21) Sydney: Churchill Livingstone.
- Titchen, A and Higgs, J. (2000). Facilitating the acquisition of knowledge for reasoning. In J. Higgs and M. Jones (Eds.) *Clinical Reasoning in the Health Profession* (2nd Ed.) (pp. 222-229) Sydney: Butterworth Heinemann.
- Tschikota, S. (1993). The clinical decision-making processes of student nurses. *Journal of Nurse Education*, 32(9), 389–398.
- Tversky, A. and Kahneman, D. (1973). Availability: a heuristic for judging frequency and probability. *Cognitive Psychology*, 5, 207-232.
- van de Wiel, M.W.J., Boshuizen, H. P. A. and Schmidt, H.G. (2000). Knowledge restructuring in expertise development: Evidence from pathophysiological representations of clinic cases by students and physicians. *European Journal of Cognitive Psychology*, 12(3), 323-355.
<http://www.tandf.co.uk/journals/pp/09541446.html>. Assessed 26/02/2009.

Volet, S. E. (1991). Modeling and coaching of relevant metacognitive strategies for enhancing university students' learning. *Learning and Instruction*, 1, 319-336.

Watson, J., Turnbull, B. and Mills, A. (2002). Evaluation of the extended role of the midwife: the voices of midwives. *International Journal of Nursing Practice*, 8, 257–264.

Weaver, E.W., Clark, K. F. and Vernon, B. A. (2005). Obstetricians and midwives *modus vivendi* for current times. *Medical Journal of Australia*, 182(9) 436.

Westfall, U. E., Tanner, C. A., Putzier, D. J. and Padrick, K. P. (1986). Activating clinical inferences: A component of diagnostic reasoning in nursing. *Research in Nursing*, 9, 269-277.

Wheeler, L. (1994). Teaching strategies for preceptors of beginning intrapartal students. *Journal of Nurse-Midwifery*, 39(5). 321-325.

Williams, L. (1989). *Report of the Research Project to Develop Role Statements for Nurses*. Brisbane, Queensland: Board of Nursing Studies.

Woods, N.N., Brooks, L. and Norman, G. R. (2005). The value of basic science in clinical diagnosis: creating coherence among signs and symptoms. *Medical Education*, 39, 107-112.

Yin, R.K. (1994). *Case Study Research: Design and Methods* (2nd Ed.) London: Sage.

Young, C. (1987). Intuition and the nursing process. *Holistic Nursing Practice*, 1(3), 52-56.

APPENDIX 1: New South Wales Nurses Registration Board Statutory Clinical Requirements

Statutory Clinical Requirements

The student midwife shall complete the following, essential midwifery experience under the supervision of a certified midwife or medical officer. In undertaking the experience the student midwife must provide a rationale for the care provided, and demonstrate an ability to interpret the significance of findings.

1. Perform 20 pre-natal examinations, including a psycho-social and physical assessment.
2. Perform 10 vaginal examinations during pregnancy or labour.
3. Participate in the provision of midwifery care for 20 pre-natal cases of complicated pregnancy.
4. Witness –
 - (a) five (5) normal births prior to assisting the woman with a normal birth;
 - (b) show evidence of having witnessed a number of complicated births, for example, forceps.
5. Assist the woman in 20 cases of labour, including the third stage. These cases should include at least 15 spontaneous births and may include a mix of both spontaneous and induced labour. No more than five (5) cases in the total of 20 may consist of any of the above complicated births.
6. Demonstrate competence in fetal monitoring methods including both electronic and Pinards.
7. Assist 20 women in the management of pain in labour using a variety of techniques and including:
 - (a) assessment of the woman's perceptions of pain;
 - (b) midwifery interventions such as: position change, ambulation, heat, massage, water;
 - (c) observing and assisting with methods such as psycho prophylaxis, hypnosis and acupuncture;
 - (d) administering inhalation analgesia by means of approved apparatus;
 - (e) use of intramuscular analgesics.
8. In regard to perineal trauma: (Desirable clinical experience)
 - (a) perform two (2) local infiltrations of the perineum;
 - (b) complete two (2) episiotomies.

9. In regard to the care of the neonate:
 - a) Receive five (5) babies following normal delivery;
 - b) Witness two (2) Caesarean sections and assist with the care of the baby after delivery;
 - c) Witness five (5) episodes of active resuscitative methods in the neonate, for example use of intermittent positive pressure respiration, endotracheal intubation;
 - d) Perform three (3) physical assessments of the neonate;
 - e) Provide care for three (3) neonates undergoing oxygen therapy.
10. Provide assistance and instruction to breast feeding mothers on 20 occasions.
11. Provide assistance and instruction for three (3) mothers who have chosen to use artificial feeding.
12. Perform 20 psycho-social and physical post-natal assessments.
13. Conduct two (2) teaching sessions on a midwifery topic.

August 1995

APPENDIX 2: Course Outline: Graduate Certificate in Midwifery

RATIONALE

This course will give graduates an opportunity to develop the required knowledge, skills and attitudes to practice midwifery. The course acknowledges a current and ongoing shortfall in the number of midwifery practitioners. It is responsive to the ongoing demand and need for education of midwives to enable them to work in either the public or private sector and in alternative models of midwifery practice which provide continuity of care in the community. This course will provide the health care industry with beginning practitioners who have demonstrated competence in midwifery practice in a range of settings and contexts.

PHILOSOPHY

This course is based on the following beliefs:

Childbirth is a normal process embedded in the human life experience. Childbirth is a dynamic, transitional process which may be subject to subtle or extreme variations;

The experience of each *Woman* is unique and inherent to her particular context;

The *Focus* of midwifery care is the childbearing woman within the context of her life experience and expectations;

Midwifery is the practice of giving the necessary supervision, care and advice to women during pregnancy, labour and the postpartum period. While midwives conduct birth on their own responsibility and care for the neonate, they also collaborate in the provision of care when complications arise. Midwifery practice includes facilitating choices for the childbearing woman and where appropriate, the family and / or significant others. The practitioner role of the midwife encompasses that of facilitator, clinician, advisor, counsellor, advocate and researcher, with an ongoing commitment to professional development.

Within a complex and changing *Health Care System* there is a need for a commitment to multidisciplinary collaboration.

Therefore *Learning Strategies* need to build the ability to reflect on experience, pursue enquiry, analyse data and use the knowledge gained to inform clinical judgement.

AIM OF GRADUATE DIPLOMA IN MIDWIFERY

The main aim of the Graduate Diploma in Midwifery is to facilitate the acquisition of knowledge, critical reflection, analytical, psychomotor and affective skills which are the bases of quality midwifery practice.

On successful completion of the course the graduate can be expected to:

- Apply skills of enquiry, analysis and clinical judgment to midwifery practice;
- Use a range of strategies to facilitate active involvement of the woman and her family in the planning health care and parenting education;
- Apply theoretical and philosophical frames of reference to midwifery practice;
- Critically examine relevant research and utilise relevant evidence to inform and guide midwifery practice;
- Demonstrate an awareness of practice issues related to the specific needs of groups in the community incorporating sensitivity to social, political, economic, cultural and spiritual factors;
- Demonstrate an understanding of the legal and ethical bases of practice and apply this understanding to practice;
- Critically examine the organisation and delivery of maternity and midwifery services within the Australian health care system and internationally;
- Give the necessary supervision, care and advice to women and their families during the pre-conception, antenatal, intrapartum and postpartum periods and to accept responsibility for the birth of the baby and the care of the neonate;
- Demonstrate the New South Wales Nurses Registration Board competencies of the midwife.

PROFILE OF THE GRADUATE

A graduate of the Graduate Diploma in Midwifery is a professional beginning midwife whose practice is based on:

- Skilful and safe practices;
- Facilitative and self-care interactions;

- Sensitivity toward the needs/feelings of mothers, families or communities in a range of contexts;
- Meaningful interpersonal relationships with mothers, families and other health care personnel;
- The incorporation of new knowledge and approaches to practice;
- An acceptance of responsibility and accountability in the provision of care;
- Legal and ethical considerations;
- An understanding of the impact of global structures and processes (eg political, economic, social, ethical and legal) which impact on midwifery practice and care.

COURSE STRUCTURE

List of approved subjects for the course

Graduate Diploma core subjects

NURS510 Investigative Methods for Clinical Practice	10
NURS511 Conceptual Frameworks for Clinical Practice	10

Midwifery Specific Subjects

NURS558 Midwifery Practice Issues	10
NURS559 The Childbearing Woman and Her Family	10
NURS565 Midwifery Practice A	15
NURS552 Contemporary Midwifery	10
NURS566 Midwifery Practice B	<u>15</u>

Total credit points **80**

Students will undertake the following pattern of study:

Code	Title	Credit Points	Pre or Co requisites	Semester
NURS510	Investigative Methods for Clinical Practice	10	Nil	1 or 2
NURS558	Midwifery Practice Issues	10	NURS565	1
NURS559	The Childbearing Woman and Her Family	10	Nil	1
NURS565	Midwifery Practice A	15	NURS559	1
NURS511	Conceptual Frameworks for Clinical Practice	10	Nil	1 or 2
NURS552	Contemporary Midwifery	10	NURS565	2

NURS566	Midwifery Practice B	15	NURS566 NURS565 NURS552	2
Total		80		

ADMISSION REQUIREMENTS

Admission is competitive and in accordance with its mission statement the Faculty of Nursing has endorsed a wide variety of entry modes to assess and select applicants.

In order to be admitted to the Graduate Diploma, an applicant shall hold current List A registration with the New South Wales Nurses' Registration Board and shall:

- a) have completed the requirements for admission to a degree of the University; or
- b) have completed the requirements of admission to a degree at any other institution recognised by the Faculty Board; or
- c) hold such other qualifications approved by the Faculty Board for the purpose of admission

And

- d) satisfy other criteria approved by the Faculty Board. (Appendix 3)>

STUDENT NUMBERS

The course is designed to accommodate 29 commencing students and 29 continuing students each semester. These students are distributed so that 16 students are allocated to the Gosford Hospital site, undertaking clinical experience within the Central Coast Area Health Service and 13 students are allocated to the Callaghan campus, undertaking clinical experience within the Hunter Area Health Service. Student numbers are limited by the availability of clinical employment places during the second semester of study and can be expanded to a potential of 35 places if suitable additional student clinical employment places can be obtained.

PROGRESSION IN THE COURSE

Variation to program

Variations from the usual pattern of progression involving subjects with a clinical component will be subject to mutual agreement between the clinical facility and the Faculty prior to approval.

Results

Results obtained by a student in a subject can be Fail, Terminating Pass, Pass, Credit, Distinction or High Distinction.

Students who obtain a terminating pass will not be allowed to progress on to the next level of this subject. They may re-enrol in the subject when it is next offered.

Time requirements

Except with the permission of the Faculty Board, a student will complete the course within two years of study from the date of commencement.

A student who has been granted credit shall be deemed to have commenced the course from a date determined by the Dean at the time that the credit is granted.

CURRICULUM 1998 (pages 7 - 11)

APPENDIX 3: Tutorial and Midwifery

GRADUATE DIPLOMA IN MIDWIFERY CONTENT - NURS565 MIDWIFERY PRACTICE A SEMESTER I, 1998

Tutorials x 2 - each 2 hours, 4 hours per week

WEEK	DATE	TOPIC
1	05.03.98 JHH 6027	1. Orientation to the course and clinical requirements 2. Anatomy and physiology - the pelvis
2	12.03.98 RW 1.50	1. Introduction to antenatal care 2. Overview of care during labour and birthing
3	19.03.98 JHH 6027	1. The menstrual cycle; introductory genetics; meiosis and mitosis; conception 2. The foetal skull and intracranial structures
4	26.03.98 JHH 6027	1. Development of the foetus, placenta and membranes and amniotic fluid. 2. Pregnancy testing, diagnosis, options and counselling. Lifestyle during pregnancy; preparation for parenthood - rationale and value
5	02.04.98 JHH 6027	1. Bio psychosocial adaptations to pregnancy 2. The first antenatal visit; calculation EDD; pregnancy screening and care options
6	09.04.98 JHH 6027	1. Foetal physiology and circulation; foetal monitoring; CTG and biophysical profile. 2. Subsequent antenatal care; pregnancy screening - value, risks and consent; examination of the pregnant abdomen; pre-eclampsia
VAC		
7	23.04.98 JHH 6027	1. Physiology of the onset of labour, contractions, first stage of labour. Pain in labour; physiology and pharmacology of pain management options 2. Care of the labouring woman; Bishop score; food, fluids and ketosis

8	30.04.98 JHH 6027	1. Physiological changes during second stage of labour: care of the birthing woman; transition; position options; pushing 2. Mechanism of normal labour and phantom delivery
9	07.05.98 JHH 6027	1. Physiology and management of the third stage of labour: active and physiological management; pharmacology of oxytocics. The fourth stage of labour 2. a Postpartum haemorrhage b Cannulation
10	14.05.98 RW 1.50	1. Shoulder dystocia Anatomy of the pelvic floor; perineal trauma 2. Perineal repair workshop
11	21.05.98 JHH 6027	1. Physiological adaptation of the newborn; Apgar score; neonatal resuscitation; changes to circulation 2. Physiology and care of the normal newborn infant;. thermoregulation; haematology; bilirubin metabolism; newborn check; newborn screening test
12	28.05.98 JHH 6027	1. Anatomy and physiology of the breast; initiation of lactation establishing breastfeeding 2. Physiological adaptations during the puerperium and care of the woman
13	04.06.98 JHH 6027	1. Maintaining breastfeeding; breastfeeding difficulties; breastfeeding the older infant; weaning 2. Breast milk substitutes; formula feeding; sterilisation The postnatal visit; postnatal contraception; circumcision Infant protection - immunisation, car safety, <u>SIDS</u>
14	11.06.98 JHH 6027	Review and revision

FACULTY OF NURSING
GRADUATE DIPLOMA IN MIDWIFERY
CONTENT - THE CHILDBEARING WOMAN AND HER FAMILY
SEMESTER 1, 1998 -

2 hours per week, Thursday. 1100 -1300, commencing 05.03.1998

Week	Topic
1	The nature of families and family development: demographic and social indicators related to families.
2	Identifying client needs; developing maternity services responsive to different needs.
3	Principles of teaching and learning; The roles of fathers, siblings and grandparents.
4	Teaching strategies; evaluation of teaching and learning.
5	An overview of women's health issues
6	Breast and cervical cancer and screening
	VACATION
7	Sexuality during the childbearing year; diseases which can be transmitted sexually.
8	Violence against women; domestic violence, sexual assault and abuse.
9	Postnatal depression
10	Cross cultural perspectives
11	Indigenous women's health and childbearing
12	Women with disabilities and childbearing
13	Loss and grief related to birth; controlling fertility, and abortion.
14	Infertility
15/16	Exam period

**FACULTY OF NURSING
GRADUATE DIPLOMA IN MIDWIFERY
CONTENT - NURS558 MIDWIFERY PRACTICE ISSUES
SEMESTER 1, 1998**

2 hours each week, Wed. 1600-1800, RW 2.30

WEEK	DATE	TOPIC
1	04.03.98	Definitions of midwifery
2	11.03.98	History of midwifery; women as healers; medicalisation of childbirth
3	17.03.98	Primary health care Philosophy and models of midwifery
4	25.03.98	The Australian health care system and midwifery International perspectives on midwifery
5	01.04.98	Modes of midwifery practice; roles of the midwife
6	08.04.98	Evidence based practice in midwifery The Cochrane data base
VAC		
7	22.04.98	Client's rights and responsibilities; Empathy and respect Choices and informed consent
8	29.04.98	Midwifery relationships Active listening
9	06.05.98	Continuity of care: Exploration and clarification
10	13.05.98	Truth telling and confidentiality
11	20.05.98	Teams and caseloads
12	27.05.98	The midwife in private practice - legal, professional and business aspects. Hospital visiting rights.
13	03.06.98	Assertiveness
14	10.06.98	Advocacy; changing childbirth practices

**FACULTY OF NURSING
GRADUATE DIPLOMA IN MIDWIFERY
ASSESSMENT SCHEDULE
SEMESTER 1, 1998 COMMENCING STUDENTS**

Semester week commencing	Subject	Assessment item
1. 02.03.98		
2. 09.03.98		
3. 16.03.98	Midwifery Practice Issues	Video 1 - interaction skills
4. 23.0.98	Investigative Methods	Critical reflection on group process
5. 30.03.98	Childbearing Woman Midwifery Practice A	Essay Take home test 1
6. 06.04.98	Childbearing Woman Midwifery Practice A	Essay Take home test 1
Vacation		
7. 20.04.98	Childbearing Woman	Literature review
8. 27.04.98	Midwifery Practice Issues	Essay
9. 04.05.98		
10. 11.05.98	Midwifery Practice A	Clinical Journal Take home test 2
11. 18.05.98		
12. 25.05.98	Midwifery Practice Issues	Clinical Practice Review
13. 01.06.98	Midwifery Practice Issues	Video 2 - interaction skills
14. 08.06.98	Investigative Methods Midwifery Practice A Childbearing Woman	Essay Clinical Journal Teaching Plan
Exam Period	Mid Prac A	Case based exam

APPENDIX 4: ANMC National Competency Standards for the Midwife



National Competency Standards for the Midwife

INTRODUCTION

DESCRIPTION OF
THE MIDWIFE

DOMAINS

NATIONAL COMPETENCY
STANDARDS

GLOSSARY
OF TERMS

Introduction

The Australian Nursing and Midwifery Council Incorporated (ANMC) is a peak national nursing and midwifery organisation established in 1992 with the purpose of developing a national approach to nursing and midwifery regulation. The ANMC works in conjunction with the state and territory nursing and midwifery regulatory authorities (NMRAs) to produce national standards which are an integral component of the regulatory framework to assist nurses and midwives to deliver safe and competent care.

The standards include national competency standards for registered nurses, enrolled nurses, midwives and nurse practitioners, codes of professional conduct and ethics, and a range of position statements and guidelines. The full list of standards, position papers and guidelines produced by the ANMC can be viewed on the website.

In 2004, the ANMC commissioned research to develop and validate national competency standards for midwives, the scope of practice of midwives, and a generic description of the midwife on entry to practice. This research, which was undertaken by a team of expert midwifery consultants, included extensive consultation with midwives around Australia. The resulting standards are broad and principle based so that they are sufficiently dynamic for practising midwives and the NMRAs to use as a benchmark to assess competence to practice in a range of settings.

What are the standards used for?

The national competency standards for the midwife are the core competency standards by which your performance is assessed to obtain and retain your license to practice as a midwife in Australia.

As a midwife, these core competency standards provide you with the framework for assessing your competence, and are used by your state/territory NMRA to assess competence as part of the annual renewal of license process, to assess midwives educated overseas seeking to work in Australia, and to assess midwives returning to work after breaks in service. They are also used to assess midwives involved in

professional conduct matters. The NMRAs may also apply the competency standards in order to communicate to consumers the standards that they can expect from midwives.

Universities also use the standards when developing midwifery curricula, and to assess student and new graduate performance.

These are YOUR standards – developed using the best possible evidence, and using information and feedback provided by midwives in a variety of settings. Included also are the principles of assessment which will assist you in understanding how these standards may be used to assess performance. We believe you will find them easy to understand, and user friendly.

ANMC would like to thank midwives throughout Australia for their willing input to the development of these standards.

Description of the midwife on entry to practice

On entry to practice, a midwife is a person who:

... having been regularly admitted to a midwifery educational program, duly recognised in the country in which it is located, has successfully completed the prescribed course of studies in midwifery and has acquired the requisite qualifications to be registered and/or legally licensed to practise midwifery.

The midwife is recognised as a responsible and accountable professional who works in partnership with women to give the necessary support, care and advice during pregnancy, labour and the postpartum period, to conduct births on the midwife's own responsibility and to provide care for the newborn and the infant. This care includes preventative measures, the promotion of normal birth, the detection of complications in mother and child, the accessing of medical care or other appropriate assistance and the carrying out of emergency measures.

The midwife has an important task in health counselling and education, not only for the woman, but also within the family and the community. This work should involve antenatal education and preparation for parenthood and may extend to women's health, sexual or reproductive health and child care.

A midwife may practise in any setting including the home, community, hospitals, clinics or health units. (ICM 2005)



The midwife will be able to demonstrate competence in the provision of midwifery care as specified in the ANMC's National Competency Standards for the Midwife.

The four domains in the provision of woman-centred midwifery care include legal and professional practice; midwifery knowledge and practice; midwifery as primary health care and ethical and reflective practice.

Legal and professional practice

The graduate midwife has a sound knowledge of the Australian health care system, relevant legislation and the role of the midwifery profession both locally and internationally. She practises within legislation and common law. Thus she complies with policies and guidelines that have legal implications and fulfil the duty of care. The graduate midwife is able to identify unsafe practice and act appropriately. She works in partnership with women and collaborates with other members of the health care team. The ability to reason, whilst being able to justify practice within legal, professional, ethical and reflective frameworks are characteristic of the graduate midwife. She accepts accountability and responsibility for her actions, whilst recognising her own knowledge base and scope of practice. She is able to identify complications with appropriate and timely consultation and referral as needed. She delegates when necessary, always providing the appropriate supervision.

The graduate midwife documents practice according to legal and professional guidelines and procedures. She demonstrates competence in oral and written communication and technological literacy. She understands and values the imperative to base practice on evidence; is able to access relevant and appropriate evidence; recognise when evidence is less than adequate to fully inform care and identify areas of practice that require further evidence.

Midwifery knowledge and practice

The graduate midwife appreciates the centrality of the relationship with women to the practice of midwifery, which she can demonstrate through working in partnership and communicating effectively. She works with women to plan and evaluate care whilst providing learning opportunities that facilitate decision-making by the woman.

The graduate midwife has the knowledge, skills and attitudes to practise midwifery according to the international definition of the role and scope of practice of the midwife. This is informed by other disciplines such as biological, physical, social and behavioural sciences; nursing; primary health care; ethics and law. The graduate midwife will be able to provide safe and effective care across the interface between hospital and community; in any setting, including the home, the community, hospitals, or in any other maternity service. She is able to comprehensively and accurately assess the needs of women and their babies and to plan, implement and evaluate midwifery care. This includes the antenatal period, during labour and birth and in the postnatal period. She supports, and may practise in, continuity of care models. The graduate midwife is versatile, adaptable and able to

respond in a range of situations including emergencies.

When women or babies have complex needs and require referral, the graduate midwife will provide midwifery care in collaboration with other health professionals. The graduate midwife protects, promotes and supports breastfeeding while respecting each woman's choice in infant feeding. She is able to initiate, supply and administer relevant pharmacological substances in a safe and effective manner within legislation.

Midwifery as primary health care

The graduate midwife practises within a woman centred, primary health care framework and is committed to seeing midwifery as a public health strategy that encompasses a broad social context. The graduate midwife understands that health is a dynamic state, influenced by particular sociocultural, spiritual and politico-economic environments. The graduate midwife has an important advocacy role in protecting the rights of women, families and communities whilst respecting and supporting their right to self determination. A graduate midwife has a commitment to cultural safety within all aspects of her practice and acts in ways that enhance the dignity and integrity of others.

Midwifery practice involves informing and preparing the woman and her family for pregnancy, birth, breastfeeding and parenthood and includes certain aspects of women's health, family planning and infant well-being. The graduate midwife has a role in public health that includes wellness promotion for the woman, her family and the community.

Whilst the graduate midwife has the skills "to do" they also have an ability to develop relationships with the women for whom they care as well as others with whom they interact in their professional lives. The graduate midwife works collaboratively with health care providers and other professionals referring women to appropriate community agencies and support networks.

Reflective and ethical practice

The graduate midwife practises in accordance with the endorsed code of ethics, professional standards and relevant state and commonwealth privacy obligations. Through reflective processes developed during the program, the graduate midwife respects diverse values, beliefs and sociocultural structures. Integral to this process is the ability to understand and identify the impact of her own culture, values and beliefs on the provision of midwifery care, whilst recognising the power relations that exist within the health system and the community.

The graduate midwife has the ability and skills to analyse and reflect in, on, and about practice. She maintains competence through continual professional development. The graduate midwife is able to assess the effectiveness of her work and regards lifelong learning as a key to continuing professional and personal development. The graduate midwife demonstrates a lively, questioning perspective that enables her to actively contribute to the development of midwifery as a discipline. She also demonstrates both computer and



information literacy which is reflected in her capacity to derive information from multiple sources. The graduate midwife has the capacity to transform this into meaningful information that impacts on practice and interactions with women and the health care system as a whole. The graduate midwife has developed both a capacity and a desire to learn from experiences in the workplace and through more formal educational opportunities. She is able to contribute to, and evaluate, the learning experiences and professional development of others, particularly through mentoring. She is able to support students to meet their learning needs and objectives in collaboration with others, and contributes to orientation and ongoing education programs.

The graduate midwife uses research to inform midwifery practice. This includes interpreting evidence as a basis to inform practice, policy, guidelines and decision-making. This implies an understanding about the way that knowledge and evidence are continuously created, applied and recreated. The development of a critical self-awareness is essential to this reflective process and is a defining characteristic of a graduate.

National Competency Standards for the Midwife

The National Competency Standards for the Midwife provide the detail of the skills, knowledge and attitudes expected of a midwife to work within the midwifery scope of practice. The definition and scope of practice provides the broad boundaries of midwifery practice, whereas competency standards provide the detail of how a midwife is expected to practise and his/her capacity to practice. These will be minimum competency standards required of all midwives who seek authority to practise as a midwife in Australia. It is expected that all midwives should be able to demonstrate that they are able to meet the competency standards relevant to the position they hold.

Overarching framework

The competency standards have an overarching framework – woman centred care. Woman-centred care is a concept that implies that midwifery care:

- is focused on the woman's individual, unique needs, expectations and aspirations, rather than the needs of institutions or professions
- recognises the woman's right to self determination in terms of choice, control, and continuity of care
- encompasses the needs of the baby, the woman's family, significant others and community, as identified and negotiated by the woman herself
- follows the woman between institutions and the community, through all phases of pregnancy, birth and the post natal period
- is 'holistic' – addresses the woman's social, emotional, physical, psychological, spiritual and cultural needs and expectations

The competency standards are underpinned by primary health care principles. These principles encompass equity, access, the provision of services based on need, community participation, collaboration and community based care. Primary health care involves using approaches that are affordable, appropriate to local needs and sustainable. These principles are outlined in the Ottawa Charter (1986).

Organisation of the National Competency Standards for the Midwife

The competency standards include domains, competencies, competency elements and cues. A domain is as an organised cluster of competencies that characterise a central aspect of midwifery practice. Within each of the domains are competencies. A competency represents a stand-alone function or functional area underlying some aspect of professional performance. Within each competency are elements. An element is a sub-section of the competency unit. The elements contain examples of competent performance known as cues. The cues are examples and prompts. These are neither comprehensive nor exhaustive and assist in assessment, self reflection and curriculum development.

Domains

The competencies which make up the National Competency Standards for the Midwife are organised in four domains. The order of the domains does not reflect their diminishing order of importance.

Legal and professional practice

This domain contains the competencies that relate to legal and professional responsibilities including accountability, functioning in accordance with legislation affecting midwifery and demonstration of leadership.

Midwifery knowledge and practice

This domain contains the competencies that relate to the performance of midwifery practice including assessment, planning, implementation and evaluation. Partnership with the woman is included in this domain.

Midwifery as primary health care

This domain contains the competencies that relate to midwifery as a public health strategy. Included are the notions of self determination and the protection of individual and group rights.

Reflective and ethical practice

This final domain contains the competencies relating to self appraisal, professional development and the value of research. The competencies, elements and cues are outlined in the following pages.



LEGAL AND PROFESSIONAL PRACTICE**COMPETENCY 1****Functions in accordance with legislation and common law affecting midwifery practice**

Element 1.1 Demonstrates and acts upon knowledge of legislation and common law pertinent to midwifery practice.

- Cues
- Practises midwifery within the requirements of legislation and common law.
 - Identifies and interprets laws in relation to midwifery practice, including the administration of drugs; negligence; consent; report writing; confidentiality; and vicarious liability.
 - Recognises and acts upon breaches of law relating to midwifery practice.

Element 1.2 Complies with policies and guidelines that have legal and professional implications for practice.

- Cues
- Complies with legal policies and guidelines, for example, occupational Health and safety, child protection, Family violence.

Element 1.3 Formulates documentation according to legal and professional guidelines.

- Cues
- Adheres to legal requirements in all aspects of documentation.
 - Documentation is contemporaneous, comprehensive, logical, legible, clear, concise and accurate.
 - Documentation identifies the author and designation.

Element 1.4 Fulfils the duty of care in the course of midwifery practice.

- Cues
- Undertakes midwifery practice in accordance with professional Australian standards for midwives.

COMPETENCY 2**Accepts accountability and responsibility for own actions within midwifery practice.**

Element 2.1 Recognises and acts within own knowledge base and scope of practice.

- Cues
- Recognises the midwife's role and responsibility for understanding, supporting, and facilitating pregnancy, labour, birth and the postnatal period.
 - Analyses strengths and limitations in own skill, knowledge and experience and addresses limitations.
 - Accepts professional responsibility and personal accountability for own practice.
 - Collaborates with other health care providers when care is outside the scope of practice.

Element 2.2 Identifies unsafe practice and takes appropriate action.

- Cues
- Identifies practices that compromise safe and effective care, or contravenes legislation, and takes appropriate action.
 - Utilises risk management and/or open disclosure policies in the follow-up of unsafe practice.

- Promotes and engages in ongoing development of the safety and quality improvement agenda to optimise health outcomes of women and their families.
- Supports other midwives or health care providers who report unsafe practice.

Element 2.3 Consults with, and refers to, another midwife or appropriate health care provider when the needs of the woman and her baby fall outside own scope of practice or competence.

- Cues
- Applies relevant guidelines or policies to ensure timely consultation and referral.
 - Develops and maintains collegial networks with midwifery colleagues and others to optimise outcomes for the woman.

Element 2.4 Delegates, when necessary, activities matching abilities and scope of practice and provides appropriate supervision.

- Cues
- Underpins delegation and supervision with knowledge of legal requirements and organisational policies.
 - Is accountable for actions in relation to the decision to educate, delegate and supervise other health care workers.
 - Uses a range of supportive strategies when supervising aspects of care delegated to others.
 - Ensures delegation does not compromise safety.

Element 2.5 Assumes responsibility for professional midwifery leadership functions.

- Cues
- Integrates leadership skills into practice.
 - Acts as a role model for other colleagues by exemplifying best practice in midwifery.
 - Provides advice and guidance in problem solving and decision making to midwifery colleagues and others as appropriate.

MIDWIFERY KNOWLEDGE AND PRACTICE**COMPETENCY 3****Communicates information to facilitate decision-making by the woman.**

Element 3.1 Communicates effectively with the woman, her family and friends.

- Cues
- Actively listens to the woman and responds appropriately.
 - Assists the woman to identify her knowledge, feelings and thoughts about her pregnancy, labour, birth and the postnatal period.
 - Uses language that is readily understood.
 - Allows adequate time to meet the needs of the woman for information, advice and support.
 - Engages the assistance of a professional interpreter where appropriate.



Element 3.2 Provides learning opportunities appropriate to the woman's needs.

- Cues
- Uses adult learning principles in the provision of information.
 - Incorporates learning opportunities into every facet of midwifery practice.

Element 3.3 Plans and evaluates care in partnership with the woman.

- Cues
- Listens to the woman to identify her needs. Involves the woman in decision making.
 - Obtains informed consent for midwifery interventions.
 - Documents decisions, actions and outcomes including the woman's response to care.

COMPETENCY 4

Promotes safe and effective midwifery care.

Element 4.1 Applies knowledge, skills and attitudes to enable woman centred care.

- Cues
- Participates in respectful partnerships with the woman and other members of the health care team.
 - Practises in ways that respects each woman's emotional, social, cultural and lifestyle needs.
 - Facilitates the involvement of family and friends as defined by the woman.

Element 4.2 Provides or supports midwifery continuity of care.

- Cues
- Demonstrates an understanding of continuity of care and carer.
 - Supports models that provide continuity of carer.

Element 4.3 Manages the midwifery care of women and their babies.

- Cues
- Organises workload to facilitate midwifery care for women and their babies.
 - Demonstrates appropriate time management and priority setting skills.
 - Ensures the effective use of resources including personnel.

COMPETENCY 5

Assesses, plans, provides and evaluates safe and effective midwifery care.

Element 5.1 Utilises midwifery knowledge and skills to facilitate an optimal experience for the woman.

- Cues
- Promotes the understanding that childbirth is a normal, physiological process and a significant life event for most women.

Element 5.2 Assesses the health and well being of the woman and her baby.

- Cues
- Carries out a comprehensive assessment of the woman and her baby.

- Interprets and acts upon information from the assessment.

Element 5.3 Plans, provides, and is responsible for, safe and effective midwifery care.

- Cues
- Assists the woman to identify and plan her preferred pathway of care.
 - Orders (within relevant legislation) and interprets relevant investigative and diagnostic tests and screening procedures.
 - Attends and supports the woman and her baby and ensures appropriate, timely midwifery interventions are undertaken.
 - Assists with the transition to parenthood.

Element 5.4 Protects, promotes and supports breastfeeding.

- Cues
- Proactively protects, promotes and supports breastfeeding, reflecting the WHO/UNICEF Ten Steps to Successful Breastfeeding.
 - Provides information to the woman, colleagues and community regarding breast feeding.
 - Respects and facilitates the woman's choice regarding infant feeding.
 - Assists the woman with her mode of infant feeding.

Element 5.5 Demonstrates the ability to initiate, supply and administer relevant pharmacological substances in a safe and effective manner within relevant state or territory legislation.

- Cues
- Maintains up to date knowledge about pharmacological substances commonly used in midwifery practice.
 - Provides information to the woman.
 - Demonstrates safe administration including drug calculations, correct route of administration, side effects and documentation.
 - Demonstrates knowledge of pharmacological substances which are safe during pregnancy, birth and breastfeeding.

Element 5.6 Evaluates the midwifery care provided to the woman and her baby.

- Cues
- Invites and acts upon constructive feedback on midwifery practice from the woman.
 - Demonstrates knowledge of the different ways in which midwifery practice can be evaluated.

COMPETENCY 6

Assesses, plans, provides and evaluates safe and effective midwifery care for the woman and/ or baby with complex needs.

Element 6.1 Utilises a range of midwifery knowledge and skills to provide midwifery care for the woman and/or her baby with complex needs as part of a collaborative team.

- Cues
- Demonstrates a sound knowledge base of relevant disease processes and health complexities.



- Demonstrates an understanding of the particular psychosocial needs of the woman and her family where there are complexities.
- Continues to provide midwifery care when collaboration with a medical practitioner or other health care provider is required.
- Uses, justifies and interprets appropriate technology to achieve best health outcomes for the woman and her baby.

Element 6.2 Recognises and responds effectively in emergencies or urgent situations.

- Cues
- Recognises and responds to any urgent or emergency situations with timely and appropriate intervention, consultation and/or referral.
 - Maintains up to date skills and knowledge concerning emergency plans and protocols.

MIDWIFERY AS PRIMARY HEALTH CARE

COMPETENCY 7

Advocates to protect the rights of women, families and communities in relation to maternity care.

Element 7.1 Respects and supports women and their families to be self-determining in promoting their own health and well-being.

- Cues
- Articulates primary health care principles and acts accordingly.
 - Works with the woman to identify and develop appropriate sources of social and community support and health care.
 - Concludes the midwifery relationship in a timely and appropriate manner.
 - Involves women and communities in maternity service development, improvement and evaluation.

Element 7.2 Acts to ensure that the rights of women receiving maternity care are respected.

- Cues
- Acknowledges, respects and advocates for the rights of the woman to be involved as an active participant in her care including her right to make informed decisions and maintain dignity and privacy.
 - Takes into account the woman's individual preferences and cultural needs.

COMPETENCY 8

Develops effective strategies to implement and support collaborative midwifery practice.

Element 8.1 Demonstrates effective communication with midwives, health care providers and other professionals.

- Cues
- Adapts styles and methods of communication to maximise effectiveness.

- Uses a range of communication methods including written and oral.
- Liaises and negotiates with colleagues at all levels to build systems and processes to optimise outcomes for the woman.
- Discusses and clarifies with relevant health care providers interventions that appear inappropriate or unnecessary and negotiates a collaborative plan.
- Demonstrates effective communication during consultation, referral and handover.

Element 8.2 Establishes, maintains and evaluates professional relationships with other health care providers.

- Cues
- Recognises the role of other members of the health care team in the provision of maternity care.
 - Identifies and responds to factors that facilitate or hinder professional relationships.
 - Invites, acts upon, and offers, constructive feedback on midwifery practice from peers and colleagues.

COMPETENCY 9

Actively supports midwifery as a public health strategy.

Element 9.1 Advocates for, and promotes midwifery practice, within the context of public health policy.

- Cues
- Acknowledges the impact of social, economic and psychological factors on women's lives.
 - Acts to address public health issues, including the promotion of breastfeeding, smoking cessation, and responding appropriately in situations where there is domestic violence, drugs or alcohol use.
 - Plans, provides and evaluates care to ensure equity of access for women from marginalised communities.

Element 9.2 Collaborates with, and refers women to, appropriate community agencies and support networks.

- Cues
- Collaborates with, and refers to, other health care providers, community groups and agencies.
 - Provides women with clear information about accessing community support agencies during pregnancy and following birth.

COMPETENCY 10

Ensures midwifery practice is culturally safe.

Element 10.1 Plans, implements and evaluates strategies for providing culturally safe practice for women, their families and colleagues.

- Cues
- Incorporates knowledge of cross cultural and historical factors into practice.



- Demonstrates respect for differences in cultural meanings and responses to health and maternity care.
- Recognises the specific needs of Aboriginal and Torres Strait Islander women and their communities.
- Recognises and respects customary law.

REFLECTIVE AND ETHICAL PRACTICE.

COMPETENCY 11

Bases midwifery practice on ethical decision making.

Element 11.1 Practises in accordance with the endorsed Code of Ethics and relevant state/territories and commonwealth privacy obligations under law.

- Cues
- Demonstrates knowledge of contemporary ethical issues in midwifery.
 - Demonstrates ethical behaviour towards women, colleagues and communities.
 - Develops and assesses strategies to address ethical issues and breaches of confidentiality and privacy in collaboration with others.

COMPETENCY 12

Identifies personal beliefs and develops these in ways that enhance midwifery practice.

Element 12.1 Addresses the impact of personal beliefs and experiences on the provision of midwifery care.

- Cues
- Recognises own attitudes, biases and values and their potential impact on practice.
 - Evaluates own practice and its effect on women and others.

Element 12.2 Appraises and addresses the impact of power relations on midwifery practice.

- Cues
- Demonstrates an awareness of the impact of gender, race and social policies on women and maternity services.
 - Works towards addressing power imbalances between health care providers, childbearing women and others in the community.
 - Acts to eliminate harassment, victimisation and bullying in the work place.
 - Demonstrates a commitment to, and respect for, co-workers.

COMPETENCY 13

Acts to enhance the professional development of self and others.

Element 13.1 Assesses and acts upon own professional development needs.

- Cues
- Identifies own learning needs through reflective practice and self evaluation.

- Contributes to self appraisal and peer review activities as appropriate.
- Prepares and actions annual professional development plans using continuing professional development frameworks.
- Seeks and engages in opportunities to maintain or update skills, knowledge, attitudes and experience.
- Demonstrates and documents own professional development.

Element 13.2 Contributes to, and evaluates, the learning experiences and professional development of others.

- Cues
- Supports students to meet their learning needs and objectives.
 - Contributes to orientation and ongoing education programs.
 - Undertakes and critiques mutual sharing of experiences and knowledge with multidisciplinary colleagues.
 - Contributes to mentoring, peer support and/or clinical supervision.
 - Seeks and engages in opportunities to maintain or update skills, knowledge, attitudes and experience.
 - Demonstrates and documents own professional development.

COMPETENCY 14

Uses research to inform midwifery practice.

Element 14.1 Ensures research evidence is incorporated into practice.

- Cues
- Values and acknowledges the importance of research and evidence.
 - Maintains current knowledge about relevant research.
 - Demonstrates skills in retrieving and understanding research evidence including levels of enquiry and forms of evidence.
 - Discusses the implications of evidence with the woman and colleagues.
 - Participates in reviews of practice and policies.
 - Supports research in midwifery and maternity care.

Element 14.2 Interprets evidence as a basis to inform practice and decision making

- Cues
- Underpins midwifery practice with current knowledge and best evidence.
 - Accesses evidence, shares and utilises to inform policy and practice.
 - Explains options while recognising the woman's right to choose.



Glossary of Terms

The ANMC acknowledges that the methods and processes in assessment of competencies will be further developed, and that the content of this document will be reviewed in three years. Comments should be addressed to:

The Chief Executive Officer
Australian Nursing and Midwifery Council
PO Box 873
DICKSON ACT 2602
Australia

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ANMC: Australian Nursing and Midwifery Council.

Appropriate: Matching the circumstances, meeting needs of the individual, groups or situation.

Attributes: Characteristics which underpin competent performance.

Core Competency Standards: Essential competency standards for registration or licensure.

Competence: The combination of skills, knowledge, attitudes, values and abilities that underpin effective and/or superior performance in a profession/occupational area.

Competent: The person has competence across all the domains of competencies applicable to the midwife, at a standard that is judged to be appropriate for the level of midwife being assessed.

Competency Unit: Represents a major function/functional area in the total competencies of a Registered Midwife in a midwifery context representing a stand-alone function which can be performed by the individual.

Competency Element: Represents a sub-function of the competency unit.

Competency Standards: Consists of competency units and competency elements.

Contexts: The setting/environment where competence can be demonstrated or applied.

Cues: Key generic examples of competent performance. They are neither comprehensive nor exhaustive. They assist the assessor when using their professional judgement in assessing midwifery practice. They further assist curriculum development.

Domain: An organised cluster of competencies in midwifery practice.

Exemplars: Concrete, key examples chosen to be typical of competence. They are not the standard but are indicative of the standard

Midwife: is a person who ...' has successfully completed the prescribed course of studies in midwifery and has acquired the requisite qualifications to be registered and/or legally licensed to practice midwifery' (ICM 2005).



APPENDIX 5: Structure of the Observed Learning Outcomes (SOLO) taxonomy

Level of Understanding	Characteristics
Pre-structural	The task is engaged, but the learner is distracted or misled by an irrelevant aspect belonging to a previous stage of mode (e.g. high school, introductory course, pre-requisite courses).
Uni-structural	The learner focuses on the relevant domain, and picks up one aspect to work with. May include heavy reliance on retelling of source materials with minimal transformation.
Multi-structural	The learner picks up more and more relevant or correct features, but does not integrate them. The student shows understanding, or ability to use, several aspects of the task, but they are unintegrated. There is evidence of understanding, coverage and effort. Characterised by the assimilation of knowledge rather than its integration. Little evidence of conceptualising much beyond the level of the given.
Relational	The learner now integrates the parts with each other so that the whole has a coherent structure and meaning. The parts cohere to make an appropriate whole. The question/task is answered appropriately. The student puts forth a good argument, covers the literature, and shows selective judgment in what is important and what is less important.
Extended abstract	The learner now generalises the structure to take in new and more abstract features, representing a higher mode of operation. The student goes beyond what is given or expected. Characterised by a high level of abstract thinking, which enables the student to generalise to new contexts, making applications or drawing conclusions that are apparently original, by bringing new phenomena under existing concepts, or by being highly abstract.

(Biggs and Collis, 1989 p. 152).

APPENDIX 6: Mechanisms for Delivering the Baby

Mechanisms for Delivering the Baby

- abdominal examination prior to delivery.
- a vaginal examination, only if necessary, and document specific indication.
- flexion of foetal head until occipital prominence emerges from under the symphysis pubis.
- extension of the head as the sinciput, face and chin sweep the perineum.
- following restitution of the head, observe the position of the occipital.
- wait for internal rotation of the shoulders to cause external rotation of the head.
- delivering the shoulders, observe that the baby's shoulders are in the anterior-posterior diameter of the pelvic outlet.
- deliver the shoulders:
- direct the baby's head in the direction of woman's coccyx until the anterior shoulder is visible.
- facilitate delivery of the posterior shoulder over the perineum by directing the baby towards the mother's symphysis pubis.
- deliver the posterior shoulder, support the baby's trunk and legs, guide him/her along an imaginary extension of the curve of Carus (lateral flexion).

Methods of Delivering the Placenta

Maternal effort:

- assisting woman to position herself so that gravity will be effective.
- encouraging woman to support her abdominal wall, as appropriate.
- encourage woman's expulsive effort as the placenta descends.
- when the placenta appears at the vulva, twisting the placenta to make a cord of the membranes. See-saw the membranes if they are trailing.

Spontaneous

- when the placenta appears at the vulva, twist the placenta to make a cord of the membranes. See-saw the membranes if they are trailing.

Controlled cord traction

- N.B. A oxytocics' must have been injected and the uterus must be contracted.
- traction on the cord must always be accompanied by counter pressure against the uterus.
- with one hand, support the uterus superiorly and posteriorly.
- apply steady even traction on the cord posteriorly until the placenta is visible.
- then direct the traction in an anterior direction.
- when the placenta appears at the vulva, twist the placenta to make a cord of the membranes.
- See-saw the membranes if they are trailing.

APPENDIX 7: Midwifery Care Activities During Birth

Readiness to deliver – assessment phase

- review the woman's history for information relevant to the safe conduct of the birth.
- observe universal precautions
- adhere to principles of asepsis
- position the mother physiologically
- ensure that the equipment required is checked and ready for use
- facilitate the natural expulsive efforts by the mother
- encourage the woman to avoid breath holding on a closed glottis
- maintain vigilance whilst head is on view
- recognise any deviating from normal and respond appropriately
- evaluate foetal heart sounds as indicated
- evaluate the vaginal loss
- perform an abdominal examination prior to delivery
- perform a vaginal examination only if necessary and document specific indication.

Birth of the baby – delivery phase

- maintain flexion of prenatal head until occipital prominence emerges from under the symphysis pubis
- facilitate extension of the head as the sinciput, face and chin sweep the perineum
- when the head is born, request the assistant to suction the air passages only if the baby has attempted to breathe or if the liquor is meconium stained
- feel for cord around the prenatal neck and when a loose loop of cord is present:
 - slip it over the baby's head.
 - if the cord is loose but will not go over the head:
 - slip it over the body as the shoulder delivers.
 - if the cord is tight, slip fingers under a loop of cord, apply two artery forceps to the cord, then cut the cord between the forceps. Unravel cord from around the neck. Recheck to ensure that there is no cord still around the neck
- observe for restitution of the head to locate the position of the occiput
- before delivering the shoulders, observe that the baby's shoulders are in the anterior-posterior diameter of the pelvic outlet
- facilitate slow delivery of the shoulders one at a time
- ask for oxytocic drug to be given, when the woman has given informed consent.
- demonstrate safe techniques when handling the baby, i.e. avoid pressure to soft tissues
- deliver the shoulders by gently direct the baby's head in the direction of the mother's coccyx until the anterior shoulder is visible.
- facilitate delivery of the posterior shoulder over the perineum by directing the baby towards the mother's symphysis pubis

- following delivery of the posterior shoulder, support the baby's trunk and legs as you guide him/her along an imaginary extension of the curve of Carus (lateral flexion)
- immediately after the birth, position the baby in accordance with the mother's wishes and to promote drainage of secretions.
- ensure that the baby is quickly dried with a warm wrap
- leave baby covered on uppermost surface with a warm dry cloth and with lowermost surface skin-to-skin on mother or wrap baby appropriately.

After the birth and delivering the placenta – after birth phase

- clamp the cord with
 - a plastic cord clamp approximately 1 cm from the umbilicus and milk the cord prior to applying an artery forceps further along the cord
 - OR
 - if a potential or actual neonatal problem/s leave approximately 10 cms length of cord before applying two Harrison Cripps
- the cord is cut between the clamps, taking into account parental wishes
- observe for signs of placental separation and the change in the contour of the abdomen
- gently palpate the uterine fundus to confirm it is contracted, and ballotable
- deliver the placenta according to appropriate methods
- methods for delivery of the placenta:
 - maternal effort
 - spontaneous
 - controlled cord traction
- record estimated vaginal blood loss.
- examine the vaginal and external genitalia systematically from anterior to posterior
- collect cord blood for laboratory testing if indicated
- examine the placenta, membranes and cord
- determine criteria for weighing placenta
- send the placenta to the laboratory if indicated
- evaluate the mother's physical status by measuring the blood pressure, pulse, uterine state, vaginal loss and perineum.
- document all relevant information.

APPENDIX 8: Structured Interview Questions

Demographic questions

The aim of this study is to examine graduate learning in nursing and how the acquisition of knowledge follows to clinical practice. To achieve this aim I wish to compare student and experienced midwives' reflections on a normal birth.

The method of data collect is by a questionnaire and a structured interview schedule. Firstly, the demographic profile of the participants requires you to complete the following questionnaire.

Name:(optional)

Age: <24

25-34

35-44

45-54

>55

What was your undergraduate Registered Nurse preparation?

To Certification

To Diploma

To Degree

(Please circle one only)

What are your years of experience as a Registered Nurse?

What are your weeks of experience as a Student Midwife?

What are your years of experience as a Certified midwife?

At what level are you working at now?

Student Midwife

Certified Midwife

Clinical Nurse Specialist

Clinical Nurse Consultant

Other (please state)

What are your qualifications now?

Completed

Uncompleted

If you have a membership of professional organisations, please list names.

How many deliveries you have conducted?

Interview Schedule

The following questions will be asked in sequence by the researcher and recorded on audio tape, to be transcribed later for analysis.

Would you please recall the last woman you assisted in a normal delivery and tell me about it. To help you recall the event would you answer the following questions?

What was the woman's Christian name? In the transcription the woman's name will be changed for anonymity.

Was this her first baby?

How long was she in labour?

Was the baby female or male?

What were the baby's apgar scores?

How long ago did the woman deliver?

I would now like you to reflect on your actions and I will ask you series of questions in sequence about the delivery:

Assessment

How did **you** know the woman was ready to deliver her baby and what assessment did you make?

What was the reason **you** decided she was ready to deliver her baby?

Did you make a plan for the delivery?

How did you prepare for the woman's delivery?

What were **you** thinking about while preparing for the delivery?

Delivery

During the delivery what were **you** doing?

During the delivery what went through your mind?

During the delivery what did **you** say to the woman?

How did **you** know what to do during the delivery?

Afterbirth

After the baby was born, what did **you** do for the baby and the woman?

At this time, what were **you** thinking?

What did **you** talk to the woman about?

Reflection

Do you remember any aspects of the delivery that caused you to change your plan?

Now that you have the opportunity to review the process, do you have any concerns that you care to discuss?

Do you have any more comments you would like to make?

Statements that will be used as prompts

Did the woman's actions cause you to act differently than you had planned?

What was the clue/s that leads you to that decision?

Did you have any alternative actions or strategies?

Could you explain that item/issue further, please?

APPENDIX 9: Interview Hours

To meet the criteria for the study each group's structured interviews were conducted within 72 hours of the relevant birth. The hours between the birth and the interview for the student midwives ranged from 21 to 72 hours with an average of 43 hours for the first interview and 12 to 60 with an average of 34 hours for the second. For the experienced midwives time ranged from 4 to 68 hours with an average of 36 hours.

A summary of the hours between the birth and the interviews with students and experienced midwives is below.

Groups	N	Average No. hours
Student 1	18	43
Student 2	15	34
Midwife	12	36

APPENDIX 10: Verbal Data Segments

Examples of verbal reports

Students' first birth

hum—and---hum I am just trying to think. ----- I just had a look to see what was happening like ---- (Lorraine)

Hum----I can't really remember I know I was a bit nervous a bit worried you know--hum----and just hoping the everything would go OK. Yea ----- (Lorraine)

It occurred to me in my mind that----the other midwife could sense that was something happening that I didn't recognise and she was still gently and calmly but – and --- (Joanna)

Then latter on I hum--- after cleaning things up and moving things out of the room and getting rid of the placenta I went back and hum ----- (Joanna)

Students' twentieth birth

Um, basically um, we did, we talked about positions and things that she wanted to be in and what not (Lorraine)

Um, I don't know. (Long pause) I can't think of anything that I was thinking of. Um, Like I wasn't worried about anything, yeh. Everything was fine and normal so um, yeh I was thinking I guess that everything was fine, normal, healthy baby, mum was okay so. So yeh that was probably all. I wasn't worried or concerned about anything. Yep. (Lorraine)

I said it's alright we're all...and um...I said with the next contraction we'll have the shoulders out, and we did but it seemed to take a long time. (Joanna)

I had the baby warmer off when she arrived I turned the baby resus trolley heater up and um, then did the palpation. (Joanna)

Experienced Midwives

Um, and just, I didn't have to ever say push she did it spontaneously, but I probably slowed down that pushing just by saying, just do it gently, just give it gentle squeezes, yeh (Fleur)

So um, yeh. I knew her peri was intact because I'd watched that at birth so I didn't really worry too much about the peri. (Fleur)

So that wasn't what I-----I was um---- just----making sure that what I was thinking, was it actually happening, was she really getting because, you know there has been times when multies are pushing and nothing happens.(Pearl)

I didn't sort of try and touch it and just as the head started to crown um-- delivered I put my hand down and um---assisted not greatly just I um (Pearl)

Examples of protocol segments prepared for coding.

Students' first birth

I just had a look to see what was happening (Lorraine)

I was a bit nervous a bit worried....hoping that everything would go OK (Lorraine)

It occurred to me...the other midwife could sense that there was something happening that I didn't recognise....she was still gently and calmly (Joanna)

Cleaning things up and moving things out of the room getting rid of the placenta (Joanna)

Students' twentieth birth

We talked about positions and things that she wanted to be in (Lorraine)

I was thinking I guess that everything was fine, normal, healthy baby, mum was okay...I wasn't worried or concerned about anything (Lorraine)

I said with the next contraction we'll have the shoulders out....we did but it seemed to take a long time (Joanna)

I had the baby warmer off, when she arrived I turned the baby resusc trolley heater up (Joanna)

Experienced Midwives

I didn't have to ever say push she did it spontaneously, but I probably slowed down that pushing just by saying, just do it gently, just give it gentle squeezes. (Fleur)

I knew her peri was intact because I'd watched that at birth so I didn't really worry too much about the peri.(Fleur)

making sure that what I was thinking, was it actually happening, was she really getting (ready to deliver) ... there has been times when multis are pushing and nothing happens. (Pearl)

I didn't sort of try and touch it ... as the head started to crown ... I put my hand down assisted not greatly. (Pearl)

APPENDIX 10 (a) Coded Verbal Data Segments.

Examples of verbal reports

Students' first birth

hum—and---hum I am just trying to think. ----- I just had a look to see what was happening like ---- (Lorraine)

Hum----I can't really remember I know I was a bit nervous a bit worried you know--hum----and just hoping the everything would go OK. Yea ----- (Lorraine)

It occurred to me in my mind that----the other midwife could sense that there was something happening that I didn't recognise and she was still gently and calmly but – and --- (Joanna)

Then latter on I hum--- after cleaning things up and moving things out of the room and getting rid of the placenta I went back and hum ----- (Joanna)

Students' twentieth birth

Um, basically um, we did, we talked about positions and things that she wanted to be in and whatnot (Lorraine)

Um, I don't know. (Long pause) I can't think of anything that I was thinking of. Um, Like I wasn't worried about anything, yeh. Everything was fine and normal so um, yeh I was thinking I guess that everything was fine, normal, healthy baby, mum was okay so. So yeh that was probably all. I wasn't worried or concerned about anything. Yep. (Lorraine)

I said it's alright we're all...and um...I said with the next contraction we'll have the shoulders out, and we did but it seemed to take a long time. (Joanna)

I had the baby warmer off when she arrived I turned the baby resus trolley heater up and um, then did the palpation. (Joanna)

Experienced Midwives

Um, and just, I didn't have to ever say push she did it spontaneously, but I probably slowed down that pushing just by saying, just do it gently, just give it gentle squeezes, yeh (Fleur)

So um, yeh. I knew her peri was intact because I'd watched that at birth so I didn't really worry too much about the peri.(Fleur)

So that wasn't what I-----I was um---- just----making sure that what I was thinking, was it actually happening, was she really getting because, you know there has been times when mults are pushing and nothing happens.(Pearl)

I didn't sort of try and touch it and just as the head started to crown um--delivered I put my hand down and um---assisted not greatly just I um (Pearl)

Examples of protocol segments prepared for coding.

Students' first birth

I just had a look to see what was happening (Lorraine)

I was a bit nervous, a bit worried....hoping the everything would go OK (Lorraine)

It occurred to me...the other midwife could sense that was something happening that I didn't recognise....she was still gently and calmly (Joanna)

Cleaning things up and moving things out of the room getting rid of the placenta (Joanna)

Students' twentieth birth

We talked about positions and things that she wanted to be in (Lorraine)

I was thinking I guess that everything was fine, normal, healthy baby, mum was okay...I wasn't worried or concerned about anything (Lorraine)

I said with the next contraction we'll have the shoulders out....we did but it seemed to take a long time (Joanna)

I had the baby warmer off, when she arrived I turned the baby resus trolley heater up (Joanna)

Experienced Midwives

I didn't have to ever say push she did it spontaneously, but I probably slowed down that pushing just by saying, just do it gently, just give it gentle squeezes. (Fleur)

I knew her peri was intact because I'd watched that at birth so I didn't really worry too much about the peri. (Fleur)

Making sure that what I was thinking, was it actually happening, was she really getting (ready to deliver) ... there have been times when multis are pushing and nothing happens. (Pearl)

I didn't sort of try and touch it ... as the head started to crown ... I put my hand down, assisted not greatly. (Pearl)

Examples of coded protocol segments with relevance data

Students' first birth

*I just had a look to see what was happening (**history, data**) 2 (Lorraine)*

*I was a bit nervous a bit worried....hoping the everything would go OK
(**rationalise action unsure**) 2 (Lorraine)*

*It occurred to me...the other midwife could sense that was something happening
that I didn't recognise....she was still gently and calmly (**rationalise
confirmation**) 1 (Joanna)*

*Cleaning things up and moving things out of the room getting rid of the
placenta (**action process**) 3 (Joanna)*

Students' twentieth birth

*We talked about positions and things that she wanted to be in (**action verbal**) 3
(Lorraine)*

*I was thinking I guess that everything was fine, normal, healthy baby, mum was
okay...I wasn't worried or concerned about anything (**rationalise action certain**)
3 (Lorraine)*

*I said with the next contraction we'll have the shoulders out....we did but it
seemed to take a long time (**action verbal**) 3 (Joanna)*

*I had the baby warmer off, when she arrived I turned the baby resus trolley
heater up (**action non-verbal**) 3 (Joanna)*

Experienced Midwives

*I didn't have to ever say push she did it spontaneously, but I probably slowed
down that pushing just by saying, just do it gently, just give it gentle squeezes
(**action verbal**) 3 (Fleur)*

*I knew her peri was intact because I'd watched that at birth so I didn't really worry
too much about the peri. (**history data**) 3 (Fleur)*

*Making sure that what I was thinking, was it actually happening, was she really
getting (ready to deliver) ... there has been times when multis are pushing and
nothing happens (**action non-verbal**) 3 (Pearl)*

*I didn't sort of try and touch it ... as the head started to crown ... I put my hand
down assisted not greatly (**action process**) 3 (Pearl)*

APPENDIX 11: Coding Scheme Tool

History

data:	objective information for clinical status
cue:	trigger in the construction of history
baseline:	establishing criteria for action
clarifies:	explores value of relationship towards baseline data interpretation

Actions

verbal:	talking negotiation and discussion
non-verbal:	describing behaviours, process and procedures method of performing a skill, moving equipment, learning

Rationalize

action:	certain
unsure	
outcome:	after reviewing verbal, non-verbal or process
confirmation:	the task is supported by action or knowledge of other midwife or doctor

Knowledge

Declarative:	knowledge
Procedural:	skill
Conditional:	attitude

High relevance, some relevance, no relevance

Each data statement is coded for its relevance to the task decisions made by a midwife during the process of a birth: the assessment, delivery, and after birth.

High relevance **3**: evidence of knowledge shown in the task decisions of birth, understanding the needs of women, while supervising the birth.

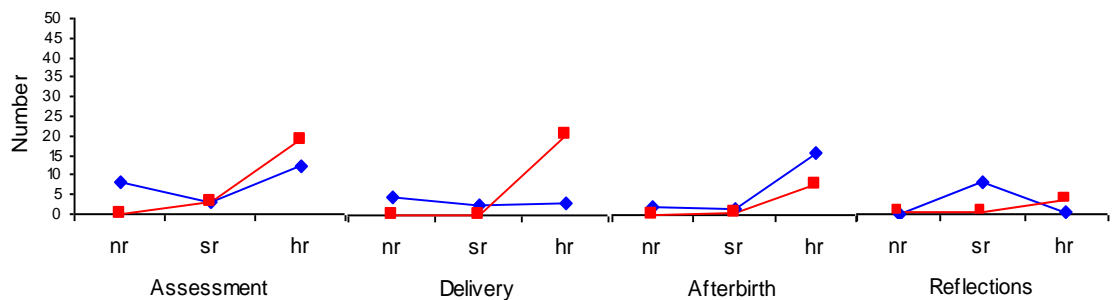
Some relevance **2**: some evidence in understanding the process and may require some confirmation and prompting from another person.

No relevance **1**: where there is little or no evidence in understanding the task decisions necessary to birth that required guidance from a supervisor.

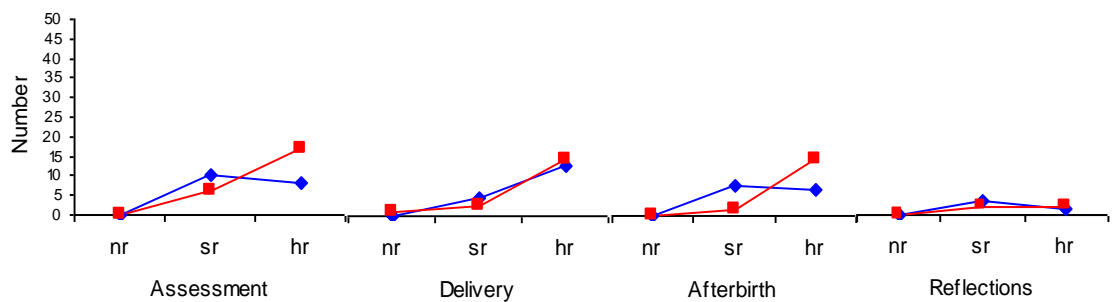
APPENDIX 12: Students' Coded Data Graphs

The pattern of students' responses with the blue line demonstrating their first birth and the red line the twentieth presented in four phases of the task (assessment, delivery, after birth and reflection). The vertical axes illustrate the number of responses and the horizontal axes of **nr** describing non relevant data; **sr** describing some relevant data and; **hr** describes the highly relevant data knowledge used by students, respectively. The names are pseudonyms.

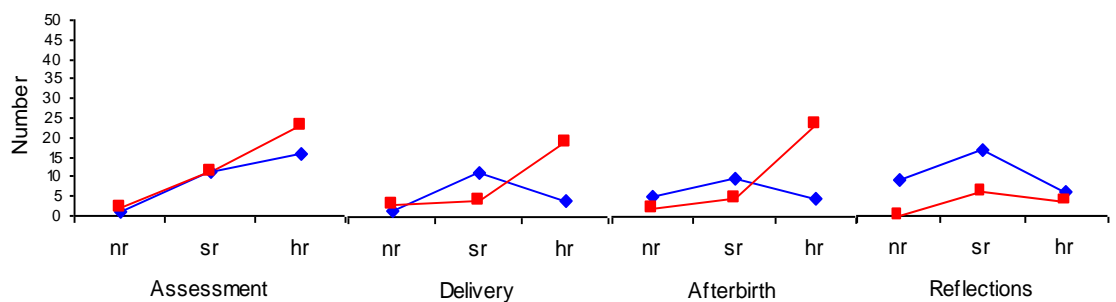
Emily



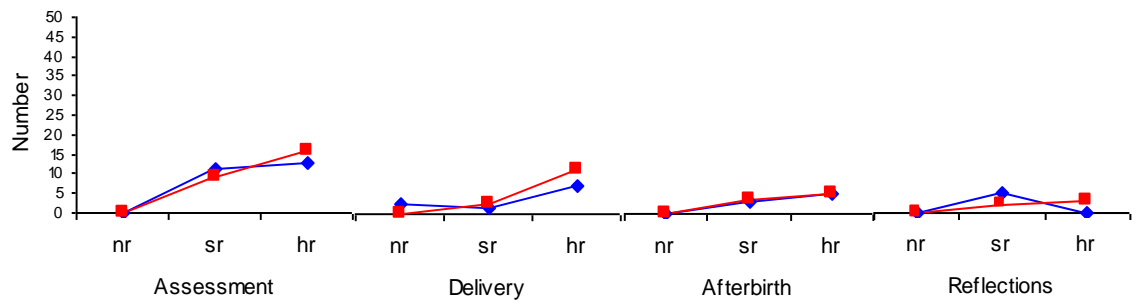
Laura



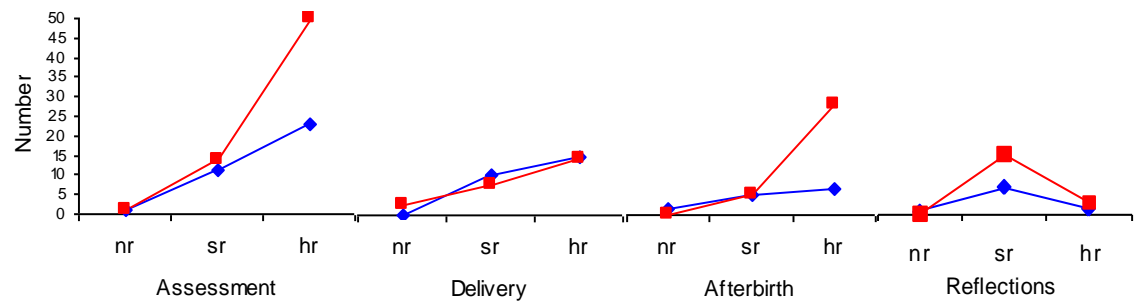
Amy



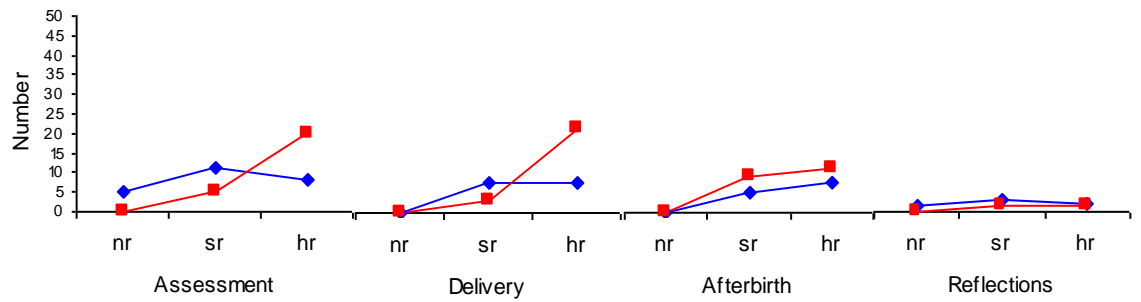
Dora



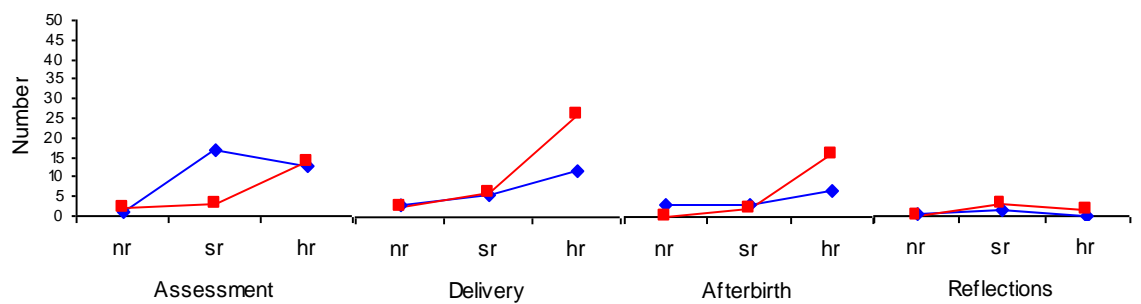
Lorraine



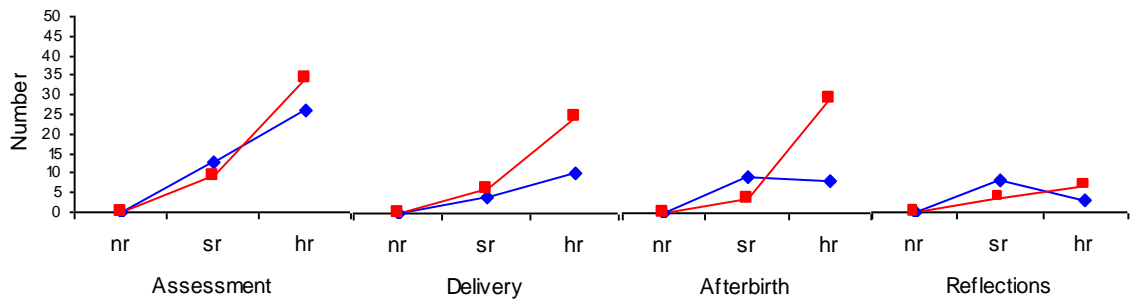
Kathy



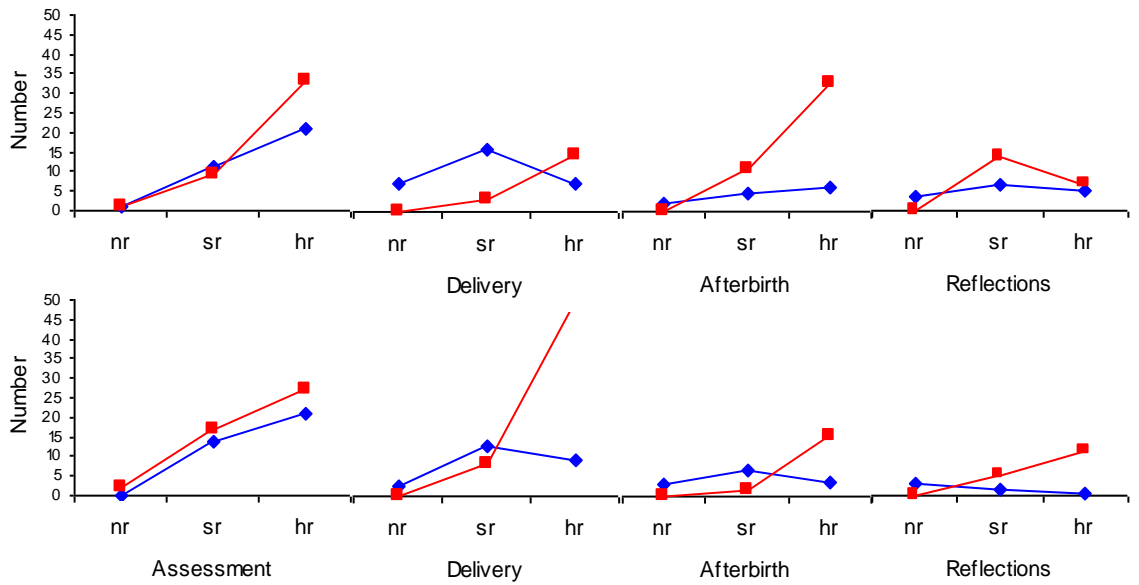
Maggie



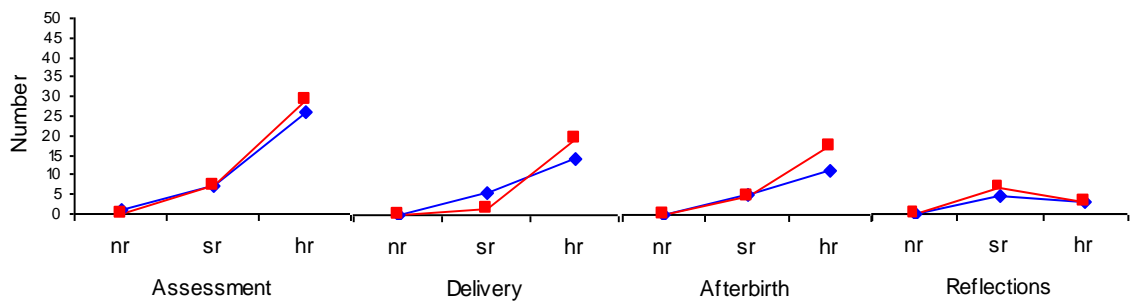
Kate



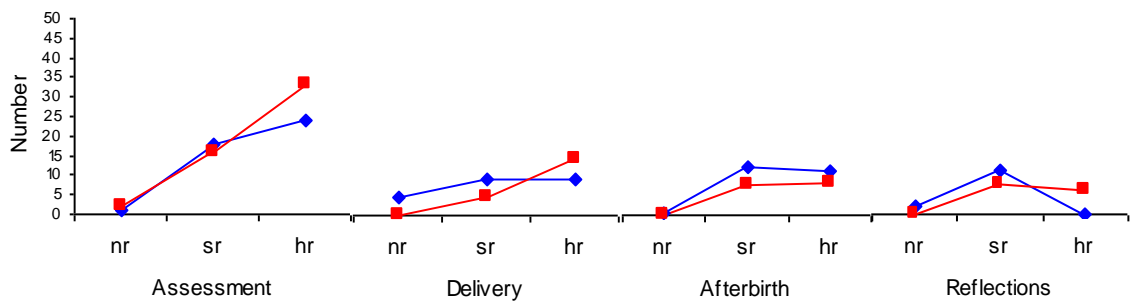
Joanna



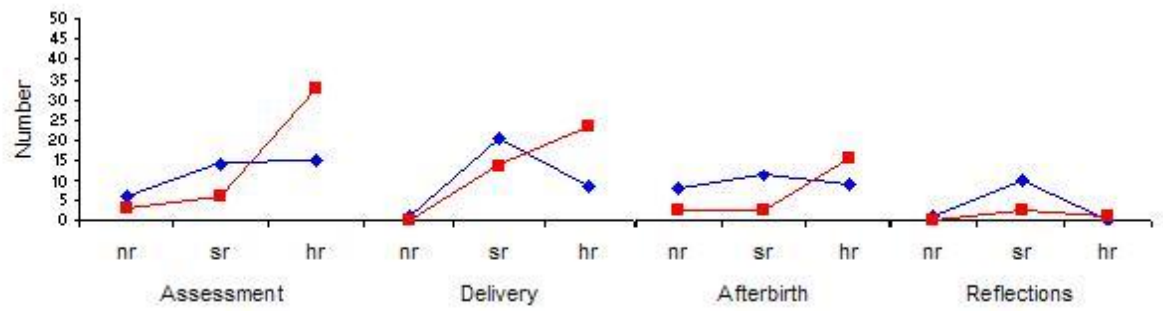
Gladys



Coral



Judy



Sasha



Valerie



APPENDIX 13: Midwives' Coded Data Graphs

The pattern of midwives' coded responses presented in four phases of the task (assessment, delivery, after birth and reflection). The vertical axes illustrate the number of responses and the horizontal axes of **nr** (describing non relevant data); **sr** (describing some relevant data and); **hr** (describing the highly relevant data) knowledge used by midwives, respectively. The names are pseudonyms.

Pearl



Daphne



Doris



Fern



Lilly



Jane



Vikki



Claire



Kerri



Anita



Sybil



Fleur



APPENDIX 14: Three sets of all subjects' raw data on a CD in MS Word®.

The CD in the envelope on the back page of the document contains three Microsoft Word© folders that contain the following:

The students' first interview (N=15): transcribed data from the structured interviews

The students' second interview (N=15): transcribed data from the structured interviews

The experienced midwives (N=12): transcribed data from the structured interviews