THESIS SUBMITTED FOR THE DEGREE OF

DOCTOR OF EDUCATION

UNIVERSITY OF LEICESTER

2008

Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme.

Submitted by Geraldine Davis

Geraldine Davis. 2008. Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme.

Abstract

Registered nurses entering a Nurse Prescriber programme participated in a mixed methods case study to explore the extent of their bioscience knowledge and the confidence with which that knowledge was held. Forty two Nurse Prescriber students, aged 26 – 55 years, from a range of job roles were recruited. Using questionnaires and interviews, both quantitative and qualitative data were obtained. An examination of the Nurse Prescribers' views of pre-registration nursing demonstrated that the knowledge gained had been related to practice but had been both superficial and lacking in breadth. The bioscience in pre-registration programmes had not sufficiently prepared the participants for their roles as registered nurses. The importance of experiences gained as a registered nurse in the practice setting in the learning of bioscience was strongly emphasised. Participants reported greater learning of bioscience by informal methods such as work experience, use of books and the Internet and discussion with colleagues than from experiences in the classroom. Interviewees placed particularly strong emphasis on the importance of learning from medical colleagues. The role of post-registration programmes emerged as important in learning bioscience because it related to the job role. Post-registration courses also emerged as significant in giving confidence to the registered nurse. Confidence increased not just in terms of the knowledge held, but also in terms of nurses' ability to communicate with patients, relatives, and doctors, their ability to understand nursing skills, and their willingness to admit when something was not known.

Key words: Bioscience, Nurse Prescriber, confidence, experience, learning.

Contents

Glossary and Abbreviations used

Term or abbreviation used	Meaning in this study
Bioscience	Biological science required in relation to nursing. This term has been used instead of biology or anatomy and physiology to encompass the wider notion of bioscience. The term in this study has specifically included anatomy, physiology, microbiology, pharmacology and biochemistry.
ENB	English National Board for Nursing and Midwifery. One of four National Boards existing under the UKCC, no longer in existence.
GNC	General Nursing Council, the predecessor of the UKCC.
Mentor	This term is used specifically to refer to those registered nurses who teach and assess nursing students in the clinical area.
Nurse Prescriber	This term has been used to describe nurses who undertake education and training to become recognised by the NMC as able to prescribe from the British National Formulary. The term Non Medical Prescriber is now used more commonly, but the participants in this study are exclusively nurses, and this is why Nurse Prescriber has been chosen as the preferred term.
Nurse Lecturer	A variety of terms are used in the literature to identify those nurses who are teachers of the formal curriculum. The term nurse lecturer has been used for clarity to encompass these terms in the literature and includes nurse tutor, nurse educator, nurse teacher, and nurse lecturer.
NMC	The Nursing and Midwifery Council is the government regulatory body for Nursing. It has responsibilities in relation to registration and professional status of the nurse, fitness to practice, and in determining the suitability of educational programmes in nursing.
Pre-registration	Before initial registration as a nurse. Pre-registration programmes in nursing are those that prepare students to become registered nurses.
Post-registration	After initial registration as a nurse. Post-registration programmes in nursing are those undertaken by registered nurses to increase knowledge and skills in relation to some aspect of the nurse's role.
UKCC	The United Kingdom Central Council for Nursing and Midwifery, the predecessor of the current NMC.

Preface

This research arose from the varied experiences of the author in nursing and teaching. It has been illuminating and rewarding. I hope the findings will lead to changes in practice to enhance the biological science knowledge of nurses.

With thanks to the Nurse Prescriber students who volunteered to participate in this study and thanks to my supervisor, Professor S Tucker for his support and guidance.

List of figures

1. Introduction

Importance of this study and background

Bioscience knowledge is a requirement for nursing. Signs and symptoms are interpreted by the registered nurse through knowledge of anatomy and physiology, laboratory results are interpreted using at least some knowledge of biochemistry, knowledge of microbiology is used in the prevention and control of infection and bioscience knowledge is also used in the administration of medications and interpretations of their effects or side effects. The variability of this knowledge at entry to a pre-registration nursing programme and at registration may affect the nurse's ability to practice effectively. With the additional roles now being taken by registered nurses e.g. Nurse Prescriber, Nurse Consultant, Nurse Specialist, Nurse Practitioner, there is an assumption by other health care professionals and by the public that the nurse's knowledge base is sufficient to take on these roles (Hinchliff et al, 2003). This assumption is based on the view that professionals under the control of a regulatory body, the Nursing and Midwifery Council (NMC), are fit for practice and fit for purpose (NMC, 2004). The NMC (2004) explains that fitness for practice does not just mean competence in the performance of skills, but also includes 'a sound theoretical underpinning of the theoretical knowledge, which informs practice' (NMC, 2004, p13). The notion of fitness for purpose is described by the NMC (2004) as the ability to adapt to change in health care provision and to have the flexibility to provide and manage care in a variety of settings.

The extent to which nurses have confidence in their bioscience knowledge is the focus of this study. Its findings are expected to be useful within the field of nurse education as a whole. The findings will have particular value for pre-registration nursing programmes, but will also be of value in programmes of Continuing Professional Development (CPD) that seek to develop specific knowledge and skills of registered nurses related to their current role. The study may also have value in the wider context of further developing adult learning theory.

Pre-registration programmes in Nursing

A typical full time programme leading to registration as a nurse in the United Kingdom (UK) lasts three years. Whilst the professional qualification (Registered Nurse) within the programmes is the same, the academic level of the programme may be at Diploma, Degree, Postgraduate diploma or Masters level (Nursing and Midwifery Admissions Service, accessed 8.5.07). All pre-registration nursing programmes, at all academic levels, combine time in the clinical setting (clinical placement) with time at university (Ash, 2006).

Prior to 1990, the majority of nurse training took place in Schools of Nursing, which were attached to one or more hospitals, with students receiving a 'hospital badge' as well as recording their registration with the General Nursing Council (GNC). At this time nursing students were employees of the Health Authority as well as students. Nurse training could be over two years as a 'pupil nurse' with qualification as a State Enrolled Nurse, or over three years as a 'student nurse' with qualification as a State Registered Nurse. In 1979 the United Kingdom Central Council for Nursing and Midwifery (UKCC) was formed to replace the GNC, with National Boards representing the interests of each UK country. In England, this devolved the role of curriculum development to Schools of Nursing (Reed and Proctor, 1993). In 1986, the English National Board (ENB) identified the need for nurse education to change. The changes included: dividing the 3 year programme into a Foundation and Branch period; changing the student to a non-employed supernumerary learner; changing the status of the qualification so that both academic and professional elements of the programme were recognised; and changing the knowledge base of the programme (Reed and Proctor, 1993). These changes, known as 'Project 2000', were implemented from 1990 by collaboration between Universities and Schools of Nursing. Education leading to registration as a nurse in the UK then moved into the University sector in the 1990s. McCarey et al (2007) explain that this was to change the programmes from service led to education led courses. Hinchliff et al (2003) use the term 'education revolution' (p20) to describe the increasing importance of academic award in ensuring that the nursing qualification had credibility and prepared nurses who saw themselves as colleagues of doctors

rather than their subordinates. The UKCC was the predecessor to the Nursing and Midwifery Council (NMC), the current regulatory body in the UK for registration of nurses and midwives (Ash, 2006). The move to University education coincided with the cessation of Enrolled Nurse training as the National Vocational Qualification (NVQ) in Care became more established (Quinn, 2000).

Today, the majority of students of nursing study at Diploma level. This is at least partly due to the non-means tested bursary applied to this level, with higher-level courses being subject to means testing (NHS Grants Unit, accessed 8.5.07). Other nursing students follow a three-year or shortened programme at Masters, Post-graduate diploma or degree level. These higher-level entry programmes in nursing have been available for many years in the United States (Smith, 1989; American Association of Colleges of Nursing, 2004) but are more recent in the UK. For all the UK nursing programmes, time in placements comprises 50% of the programme and attendance during this time is for 37.5 hours per week. The placements are offered in a geographical area agreed with the Strategic Health Authority (SHA), and the SHA pays the fees for education to the University. Placements are often at considerable distance from the university base, so that access to the university resources may be limited, and resources at the placement base will vary considerably. Placements may include, for example, hospital wards and departments, GP surgeries, community mental health settings, district nursing teams, hospices, nursing homes and work in prisons or other settings. This means that each student has a different placement experience. The nursing programmes are typically 46 weeks in duration each year.

While the regulatory body, the NMC, governs all programmes leading to the qualification of Registered Nurse, there is no prescribed bioscience content for the curriculum. This flexibility has been in place since 1979 with the creation of the National Boards, and remains the case today (Salvage, 2003). The guidance is broad rather than specific, for example the guidance includes the need to provide ‘adequate knowledge of the sciences on which general

nursing is based' (NMC, 2004, p20), but does not specify the breadth or depth to which anatomy, physiology, biochemistry, microbiology or pharmacology should be included. The NMC does not offer specific guidance on bioscience education. However, each programme has to be approved by the NMC and is reviewed through a system of annual monitoring (NMC, 2006a). The aim of the NMC appears to be to give ownership and context to the Higher Education Institution (HEI) by allowing a local curriculum to develop. NMC programme validation does check that the content of curricula is appropriate. This check occurs as a scrutiny of the curriculum documents by visitors appointed by the NMC (registered nurses), followed by a meeting of the NMC visitors with representatives of the University and an external academic (NMC, 2006a). The NMC visitors make the judgement as to whether the curriculum appears to cover all elements of the 'Standards of proficiency for pre-registration nursing education' (NMC, 2004), the external academic aims to ensure academic parity with other UK programmes. NMC validation can result in recommendations for changes to the curriculum, or there can be an insistence on certain changes to the curriculum before it is implemented (NMC, 2006a). Informal information from HEIs suggests that changes in relation to theoretical content are rarely prescribed.

All programmes in HEIs also have to meet Benchmark statements regarding academic level set by the Quality Assurance Agency for Higher Education (QAA). For programmes in nursing, these are the 'Health care programmes: Nursing' statements (QAA, 2001). These include slightly more guidance on inclusion of bioscience in nursing programmes in the statement 'the structure and function of the human body, together with a knowledge of dysfunction and pathology' (QAA, 2001, p4) and the list of 'pharmacology, immunology, microbiology, epidemiology, nutrition, genetics, anatomy, physiology, pathophysiology' (QAA, 2001, p11) which is included but not expanded further. Thus the detail of inclusion of bioscience in the pre-registration nursing curriculum is not specified by the QAA or by the NMC.

Role of the Nurse

Nurses work independently of, and collaboratively with, other nurses as part of an ever-growing multi disciplinary team (MDT). The Department of Health has identified the importance of collaborative working between professions in its policy documents (DoH, 2006 and 2007b) and this has driven interprofessional collaboration from a strategic level. The registered nurse, whatever their academic qualification, is required to be independently accountable for his or her actions or omissions (NMC, 2004). Nurses have become more independent of the medical staff in many of their roles, and there is now less frequently a relationship of subservience between doctor and nurse (Salvage, 2003). Hinchliff et al (2003) suggest this is based in the university education of nurses that encourages greater confidence and autonomy, but also in the growing number of nurse specialists who have specific rather than general roles giving them greater independence. Examples of these roles include nutrition nurse specialist, diabetes nurse specialist, respiratory nurse specialist, and heart failure nurse specialist. The implementation of Project 2000, has to an extent emphasised the caring role of the nurse as opposed to the curing role of the doctor (Trnobranski, 1993), this is explored in the literature in chapter 2. Nurses are expected to have an understanding of diseases and treatments in order to communicate with other health professionals and be effective in their role within the MDT. The nurse must also communicate information to patients to enable patients to understand their condition or treatment and to educate the patient as part of health promotion. The roles of nurses are diverse and are practised in many different settings (Cheek and Jones, 2003). For example a newly qualified nurse may practise as a staff nurse in a general or specialist in-patient ward or department, or may practice as part of a community team visiting patients in their own home. The range of departments, and the scope of the practice, varies considerably from job to job. In addition, nurses are taking more roles from medical staff (Courteney, 2002). These roles include prescribing medications, ordering and interpreting laboratory tests, performing minor surgery and performing invasive investigations such as endoscopy. All of these aspects of a nurse's role require relevant biological knowledge. The NMC clearly state that the nurse must be a knowledgeable practitioner, rather

than merely competent (NMC, 2004). The NMC (2004) use standards of proficiency as measures of readiness to enter the professional register, these standards are articulated in relation to domains such as care delivery and professional and ethical practice. The standards are not specific statements of competence for identified skills or knowledge but are more general statements such as 'demonstrate the safe application of the skills required to meet the needs of patients' (NMC, 2004, p30).

Knowledge of bioscience

The entry gate into nursing has widened, students can now enter nursing having never studied biological sciences before at any level, for example students entering through the NVQ (National Vocational Qualification) level 3 route will have well developed practical skills in caring, but may not have formally studied biology at school. Other students will have achieved A grades at GCE 'A' level in the three sciences, and yet others will have a first degree in a science subject. It is clear that bioscience knowledge on entry to nursing is at best variable. Instead of increasing, the biological content of the nursing curriculum has diminished over the last ten years, with many students and lecturers of nursing having a lower level of biological knowledge than previously (Wynne et al, 1997; Courteney, 2002). Courteney (2002) relates this change to the lower level of bioscience knowledge in nurse lecturers. Jordan (1994) and Clarke (1995) identify that behavioural sciences have been given an increased proportion of time in the curriculum to the detriment of the bioscience content. It is not clear whether the changes in entry to nursing, as well as the changes in the curriculum, have had an impact on the knowledge base of the newly qualified nurse. With the advent of Nurse Prescribing, the need for nurses to have adequate biological knowledge has been highlighted (Bradley et al, 2006)

New roles that nurses are undertaking include the job of prescribing a wide range of medications from the British National Formulary, that is to independently prescribe medication without reference to a member of the medical staff, as a Nurse Prescriber. To become a Nurse Prescriber, a nurse must be experienced (at least three years post-registration) and must undertake a period of preparation; this preparation is the Nurse Prescriber

programme approved by the NMC (NMC, 2006b). These programmes contain bioscience teaching at an academic level equivalent to the third year of an undergraduate Honours degree programme (NMC, 2006b). Employers (usually the NHS) sponsor registered nurses to undertake this period of CPD training and assessment. Latter et al (2007) describe the development of nurse prescribing in the UK from the pilot in the 1990s, through the national programme of education commenced in 1999 for some community nurses, to the current day where the formulary and the type of nurses undertaking the programme has increased in breadth. The Nurse Prescriber programmes draw together nurses from a diverse range of settings, enabling exploration in this study of the ways in which bioscience enters the role of the nurse across a range of specialities. There is an opportunity to explore the use of biosciences in relation to the newly emerging Nurse Prescriber that will cross the different branches of nursing as well as the range of roles nurses fulfil. This move to Nurse Prescribing means that nurses are being asked to return to a more medical model of cure, which is a substantial shift from the model of care that has been emphasised since Project 2000 was implemented (Bradley et al, 2006). That is, Project 2000 curricula focussed on the nurse's role in promoting independence and health by the use of knowledge to assist individuals to undertake activities of daily living (Trnobranski, 1993). The emphasis shifted from one of measurement of physical parameters and promoting cure to the exploration of social and psychological well-being and their impact on the need for assistance with care. Being a Nurse Prescriber, in contrast, requires the nurse to make a rapid and detailed assessment of a patient's illness or presenting symptoms and signs, and prescribe a suitable medication to alleviate symptoms or cure illness (Bradley et al, 2006). This substantial shift in emphasis of nursing practice is explored in the literature review in chapter two.

Focus of this study

The study aims to explore registered nurses' perceptions of their own bioscience knowledge, the ways in which this knowledge has been gained, and the confidence with which it is held. It is hoped to develop an increased understanding about the relative importance of prior knowledge, initial nurse

education, clinical experience and interest in relation to the bioscience knowledge held by the individual nurse and the confidence with which it is held. The study is exploratory and endeavours to discover nurses' own perceptions of their biological knowledge, its acquisition and the level of confidence in it.

Key research questions

The main research questions are:
For nurses starting a Nurse Prescriber programme,

1. What is the perceived breadth and depth of the bioscience knowledge held by nurses in relation to their practice, and how confident are these nurses in their knowledge?
2. How have nurses gained their knowledge of biological sciences?
3. What is the perceived relative impact of formal and informal methods of learning on acquisition of bioscience knowledge?

The first question sought to discover whether nurses who have been qualified for some time did in fact have confidence in their knowledge of the biosciences in relation to their current work role. Using structured questionnaires and semi structured interviews, base line questions were asked about the nature of the nurses' work and their level of responsibility, their grade in post and the length of time they had been qualified as well as their academic qualification and their study of biosciences both before they entered nursing and since. Knowledge of areas of anatomy, physiology, microbiology, pharmacology and biochemistry are explored.

The second and third questions aimed to discover the ways in which nurses had acquired their knowledge of the biosciences and whether they considered formal or informal methods more or equally important in the acquisition of this knowledge. Formal methods include teaching and instruction in relation to an academic programme of study, informal methods include knowledge acquired by exposure to a range of conditions or tests in the clinical area, unplanned or opportunistic learning or teaching, or a particular interest which motivated

individual learning. These questions were explored through both questionnaires and interviews.

This thesis follows a standard structure, leading from the aims and design of the study, and analysis of the literature, to a rationale for the methodology chosen and presentation of results and discussion.

The literature review analyses the research relating to bioscience in nursing, and extends to examine aspects of professional knowledge and adult learning theory. The literature identifies a number of themes including the entry level bioscience knowledge of nursing students, the teaching of bioscience, and the curriculum changes which have occurred in pre-registration nursing programmes. Differences in students' and nurse lecturers' considerations of the value that should be placed on bioscience education also emerge from the literature and the lack of theory to practice links made in bioscience teaching are explored. Changes to the education of nurse lecturers from a model of developing expert knowledge related to nursing, to one of developing expert knowledge of teaching, are also referred to in the literature. A move from the requirement for nurse lecturers to obtain the Diploma in Nursing as a basis of their expert theoretical nursing knowledge, to the alternative requirement for nurse lecturers to have a teaching qualification such as the Certificate in Education is explored here.

The literature review about bioscience in nursing, and the wider context of adult learning and nurse education, demonstrates that gaps exist in the current research literature. The literature does not identify whether nurses have bioscience knowledge related to their current role, even if their wider bioscience knowledge is weak. For example, a Diabetes Nurse Specialist may have extensive knowledge of insulin and blood glucose control, but very little knowledge of pharmacology for heart conditions. Equally a nurse working on a medical ward may have good knowledge of the heart and renal systems, but very limited understanding of skeletal anatomy. This knowledge related to the specific roles of the individual nurse has not been explored in the literature. This exploration of individual roles is beyond the scope of the

current study but nurses' perceptions of their bioscience knowledge in relation to their role are explored. Given the wide range of roles undertaken by nurses, responses from different nurses are likely to be very specific to their individual roles.

Although research into 'adult learning theory' per se was outside the scope of this study, the literature on adult learning has been referenced. As a lecturer, awareness of the differences in ability and relevant background knowledge between individual students is essential. As a lecturer, the planning and management of a programme of study takes into account the needs of the learners and the importance of exposing students to a range of ideas and theories to develop learning. The lecturer is managing the teaching in order to promote learning; the individual learning comes from the student. Exploring the perceptions of nurses regarding how they have learned bioscience aimed to allow a picture to be captured of the various factors that contributed to learning of bioscience in relation to background, teaching, work role and adult learning theory.

The literature does not identify whether nurses have learned the bioscience knowledge they do have from their formal education or through their work, or by other means. Questions have been asked about the content of curricula, and about the methods of teaching. There has been little exploration of the knowledge nurses gain through their experience and daily work. With limited previous work in this area, exploration of the experiences of a small number of individuals seemed appropriate before carrying out any study trying to link cause and effect. This exploration provided an opportunity to link theoretical and practical aspects of the nurses' role. The newly emerging role of the Nurse Prescriber offered an opportunity to explore the bioscience knowledge of a group of registered nurses who are considered by their employers and by the NMC to be experienced in their roles. That is, each nurse is considered to have specific skills and knowledge in relation to the field of work in which they are employed. There is an expectation that an experienced employee will have a reasonable level of confidence in their knowledge in relation to the role they fulfil. Exploring with individual nurses their confidence in their

bioscience knowledge and their understanding of how their knowledge has been acquired suggested that a qualitative study was required, providing in depth individual analyses. The rationale for this can be found in chapter three.

A case study approach was adopted (Bassey, 1999; Gillham, 2000) using students on the Nurse Prescriber programme as the case. These students were all considered by their employers to be experienced nurses and were from a diverse range of work settings. Data were collected using a structured questionnaire and a semi-structured interview. The study generated both quantitative and qualitative data. Descriptive statistics were applied to the numerical data to provide a summary of findings. The design of the research includes a rationale for the case study approach that was adopted. The methods are described and an explanation of the coding system used for qualitative data analysis is provided. These matters are explored in some detail in chapter 3.

Conclusion

In a time of change, nurses are taking on an increasing range of diverse roles in many different settings. The ability of staff in HEIs to develop a curriculum that adequately prepares for these roles is challenging. The NMC requirements are clearly stated, but address the overarching themes of topics for inclusion in the curriculum rather than the detail of knowledge requirements. With the introduction of Nurse Prescribing, the need for sufficient bioscience knowledge by nurses, enabling them to justify prescribing choice, has become clear. This study explores the current situation of those nurses undertaking a Nurse Prescriber programme and makes recommendations to enable more effective preparation for the Nurse Prescriber role in future curriculum developments.

2. Literature Review

The main literature review is focussed on biosciences in nurse education. Brief reference is also made to professional knowledge and to adult learning theory, as both play a role in this study. The literature search explored bioscience knowledge of registered nurses and the bioscience links between the theory and practice of nursing in preparing for the role of registered nurse. Views of nurse lecturers and nursing students as well as registered nurses are explored. Literature on the theme of bioscience and nursing has been reviewed back to the 1970s to reflect the changing curriculum since that time. The significant changes to the curriculum have been referred to in chapter 1. Review of the literature on professional knowledge was focussed on exploring the theory to practice links of bioscience knowledge. Brief exploration of the literature on adult learning theory aimed to seek out and explore any themes to further elucidate aspects of learning by students who are all 18 years of age or older.

Biosciences in nurse education

The biological sciences in nursing were traditionally taught by doctors and prescribed to the medical model of care (Hayward and Akinsanya, 1982). This was true in both pre-registration nursing programmes (i.e. those leading to a qualification as a registered nurse) and post-registration programmes (those programmes considered as continuing professional development, and undertaken once having registered as a nurse). In the medical model of care, the biosciences were linked to disease processes, signs and symptoms, and treatments. Wynne et al (1997) present a discussion paper in which they summarise the changes that have occurred in biosciences in nursing education. These authors particularly focus on the notion of nursing as a developing profession that was trying to emerge from its subservience to medicine. Medicine, certainly until the 1970s, still had authority over nursing. The authors identify the dissatisfaction with the purely medical model that influenced nurse training in the mid twentieth century, which did not sufficiently emphasise the psychosocial aspects of ill health. Wynne et al (1997) argue that this led intentionally away from medical dominance and

towards increased emphasis on psychology and sociology in the pre-registration curriculum, but unintentionally away from the inclusion of bioscience in the nursing curriculum. That is, Wynne et al (1997) indicate there was not a deliberate attempt to reduce biosciences in the curriculum but that this did occur as a consequence of the move to greater inclusion of behavioural sciences. These authors use the term 'incomplete holism' to describe the current emphasis on psychosocial aspects in the curriculum and the limited emphasis on bioscience. Jordan et al (2000) support this view in their study of mental health nurses, these authors found that bioscience content was curtailed rather than made more relevant to the student group, despite service users identifying the importance of bioscience knowledge for nurses. The lack of pharmacology knowledge of nurses, demonstrated by a lack of information about drug therapy, was identified by service users as a factor that needed addressing by increasing the bioscience content in the curriculum. However, nurse lecturers and some students did not see the need to learn the bioscience related to drug action. Jordan et al (2000) suggest that the reason for this was the focus of bioscience on general nursing, so that mental health lecturers and students did not make use of bioscience, and did not see the connection to practice, leading to a belief that it was of no value.

In further exploring this move away from a medical model, several authors (Hayward and Akinsanya, 1982; Courteney, 1991 and 2002; Clarke, 1995; McKee, 2002) have commented on the lack of ability of nurse lecturers in relation to bioscience. A change in the education of nurse lecturers in the 1970s meant that biosciences was no longer part of the teaching course and newly qualified nurse lecturers were relying on bioscience knowledge gained during their own pre-registration training (Hayward and Akinsanya, 1982). That is, the Certificate of Education teaching course did not expand the bioscience knowledge base of the nurses undertaking this course, instead it introduced theories of teaching and learning in a general sense, and the students were then expected to apply this theory to their own professional area. In Hayward and Akinsanya's (1982) study, 324 out of a possible 487 nurse lecturer students across England and Wales completed questionnaires.

Fifty four per centof trainee teachers in this study expressed anxiety about their lack of bioscience knowledge. Most nurse lecturer students in the study (84.6%) expressed dissatisfaction with this lack of engagement with or development of their knowledge base, as the knowledge gained through pre-registration nursing training may not have been recently acquired and the confidence nurses had in their own level of bioscience knowledge when they entered an education programme was often lacking. Nurse lecturers were learning how to teach, but not learning any more or in any greater depth about the material they were required to teach. Other publications have identified that many nurse lecturers have weak life science backgrounds (Courteney, 1991 and 2002; Clarke, 1995). For example, Clarke identifies that both nurse lecturers and mentors lack bioscience knowledge (Clarke, 1995) and Courteney (1991) suggests that students with qualifications in 'A' level biology had a higher level of knowledge of biosciences when compared to some nurse lecturers. She examines the formal qualifications held by students and lecturers and reports that the students have higher levels of formal bioscience qualification. Five per cent of the nurse lecturers held 'A' level biology, whereas twenty six per cent of the students surveyed held 'A' level biology.

Trnobranski (1993) identified that nursing moved away from the medical model of 'cure' to one of 'care' with the advent of Project 2000, a new curriculum, in the early 1990s. She argues for greater emphasis on the 'intelligent practitioner' (p495), that is the nurse who understands enough to be able to practice safely and adapt to changing conditions in the patient. Trnobranski (1993) sees biological knowledge forming an essential part of a model of nursing and bemoans the fact that the importance of bioscience has been overshadowed by emphasis on psychology and sociology since Project 2000. She argues for an increased number of nurse lecturers with bioscience degrees to equip them to teach the biological concepts and relate these to nursing practice. None of the literature argues for a return to teaching of bioscience by medical staff, however Wynne et al (1997) end their paper with a very limited argument trying to persuade the reader that physiologists should teach pure physiology and nurse lecturers should then teach applied

physiology. The argument is weak because it does not base itself on any empirical evidence. There is a concern here that the physiologists are keen to increase their sphere of teaching in the academic setting, without taking on their own previous argument that the biosciences should not be divorced from nursing practice.

Several authors recognise a reduction in the bioscience content of the pre-registration nursing curriculum from this time (1990s) and the need for nursing to address the issue of bioscience in the nursing curriculum after the move away from the medical model left a gap in this area (Trnobranski, 1993; Clarke, 1995; Wynne et al, 1997; Friedel and Treagust, 2005). Hayward and Akinsanya (1982) tested student nurses' knowledge of science and found it to be poor overall and that the attitude to bioscience learning was often one of anxiety. Other authors have demonstrated a lack of bioscience content in the nursing curriculum (Clarke, 1995; Wynne et al, 1997) and a lack of bioscience knowledge amongst nursing students (Clancy et al, 2000). Wharrad et al (1994) surveyed 16 nursing degree courses in the UK and found the teaching hours, content and science entry criteria for these courses to be very varied. A number of studies explore the discrepancy between students' attitudes and expectations of a nursing programme and those of the lecturers. Friedel and Treagust (2005) identify more positive attitudes to bioscience by learners than by lecturers. Jordan (1994) noted that students found bioscience more relevant to their practice than did their lecturers. Jordan et al (2000) identified a discrepancy between students' needs for bioscience knowledge (which was considerable) and how the lecturers responded to those needs (which was to reduce content). There is a sense that lecturers' expectations of the nurses' role do not match the actual role as it is carried out in the workplace, with nurses needing or wanting to use more knowledge than the lecturers perceive to be required (Clancy et al, 2000). As suggested earlier, there may also have been a lack of lecturer knowledge in this area.

Friedel and Treagust (2005) present a research paper of a study undertaken in New Zealand using a curriculum enquiry approach to examine bioscience in the pre-registration nursing curriculum. This study endeavours to compare

the curriculum intended by the New Zealand Nursing Council with the curriculum prescribed by the educational institution, and the curriculum perceived by nurse lecturers and that experienced by the student nurses. Both quantitative and qualitative data were collected using questionnaires, documents and focus groups. This is a well-designed study, with 155 student participants and 29 nurse lecturer participants. Statistical summaries are provided for the numerical results and significance levels of results are clearly indicated. A number of findings from this study are worth noting here. Firstly the students had more positive attitudes to bioscience in nursing education than did their lecturers (with mean scores of 4.32 and 3.88 respectively on the paired samples and independent samples t – tests demonstrating statistical significance at 0.001). Secondly, as expected, students' confidence in their ability to explain bioscience topics (mean value of 3.47) was lower than the confidence of the lecturers (mean value of 3.70), but the results here were not significantly different. Thirdly, the students did not consider there to be enough bioscience in the curriculum (81% of students stated they wanted more bioscience in the curriculum), they reported that bioscience was difficult but relevant. In their concluding remarks, Friedel and Treagust (2005) suggest that nurses' understanding of procedures and disease is probably not as good as doctors and patients think it is. This study was undertaken in New Zealand, not in the UK, and it was with students entering only degree programmes, whereas in the UK the majority of students currently in preparation for nurse registration are undertaking diploma programmes. Also, the students in the study had either gained a pass in a science exam at age 18 or had been involved in preparatory courses in bioscience before starting their degree in nursing. These factors need to be considered when comparing the UK situation, it could be that the higher science at entry level gives higher expectations. However, the findings of the study do not disagree with findings from other UK studies. For example Jordan et al (1999) and Courteney (1991) showed that UK nursing students wanted more bioscience in the curriculum, Gresty and Cotton (2003) demonstrated that UK nursing students were anxious about studying biosciences but keen to learn this aspect of the curriculum. Some of this anxiety was about the extensive new vocabulary; other students expressed anxiety about their lack of knowledge

and their concern that they may be seen as inadequate in relation to their peers. The students recognised the importance of this aspect of the curriculum and were keen to learn biosciences.

There is a clear need for nurses to use bioscience in their everyday work (Clarke, 1995; Clancy et al; 2000, Courteney, 2002), whether it be in relation to wound healing and choice of wound dressings, understanding side effects of medications, promoting health, knowledge of digestive processes or in more specialised work such as endotracheal intubation and respiratory support. Burton and Stewart (2003) highlight the increasing need for nurses to have knowledge of genetics to inform communication with patients about treatments or to support genetic counselling. Danielson and Berntsson (2007) undertook a study of 219 nurses three years after registration in Sweden and found these nurses reported that bioscience and medical science knowledge was the most important knowledge needed to carry out their work. The study is particularly useful because it includes nurses from a variety of work settings, including general hospital, mental health and community. The study also reports the changes to the pre-registration nursing curriculum that have occurred in the Swedish setting, reflecting considerable similarity to the UK setting. Yet the relevance of taught biosciences to the practice of nursing has been questioned, with several authors identifying a theory to practice gap (Courteney, 1991; Jordan, 1994; Davies et al, 2000). Courteney (1991) identified that students' perceptions of their need for knowledge of anatomy was different to the perceptions of lecturers, who assumed less knowledge was required. Fifty one per cent of students compared with twenty six per cent of lecturers identified anatomical knowledge as most important out of a choice of other biosciences (physiology, microbiology, pharmacology) or social sciences (sociology, psychology) – reasons given for these differences related to the imbalance between social sciences in the curriculum and biosciences, with social sciences clearly marked as having too much prominence. The participants consisted of 85 third year students and 20 nurse lecturers across three Schools of Nursing across the UK – this represented 67% and 62% response rates respectively. She used a questionnaire as a survey tool, gaining both

quantitative and qualitative data. She reports her results by indicating the percentage of the participants responding in each way to the statements on the questionnaire. Although a statistical analysis is reported to have been applied to the results, there is no report of the significance levels, however the figures demonstrate very clearly the findings the author reports. In summary she found that students considered there was too much behavioural science and insufficient depth and breadth of bioscience in their programmes, while lecturers stated they were inadequately prepared to teach bioscience and often used self-directed study to deliver the bioscience in the curriculum although students considered these methods the least effective. Students indicated that most of their bioscience knowledge was gained from their experience in the clinical area. Wharrad et al (1994) found that practical and self-learning methods were more useful than didactic methods in the learning of biosciences in nursing. Jordan (1994) identified that students found biosciences relevant to practice to a greater degree than their lecturers, with lecturers favouring emphasis on behavioural sciences. Wynne et al (1997) describe the way in which teaching bioscience ignores the link with practice while learning in the workplace appears more relevant to students than learning in the classroom.

Looking at more contemporary studies linking learning of bioscience to the practice setting, Davies et al (2000) demonstrated that students preferred teaching which embedded bioscience knowledge in practice. These authors suggest a model of bionursing pedagogy, embedding bioscience teaching in real patient examples, with an illustration of the teaching of physiology of hypothermia in relation to the post-operative patient. In their study of 17 high performing staff nurses, Rochester et al (2005) recommended the use of real nursing situations from practice as the basis of teaching in the classroom. This Australian study was not looking at bioscience knowledge but did recognise the importance of integrating learning into the practice setting so that it was grounded in the reality of work rather than theory-based. Clancy et al (2000) used a questionnaire with student nurses (n=153, response rate = 96%) to find out whether they had bioscience knowledge to underpin practice, the researchers report their findings that students had not received education

which enabled them to apply knowledge of drug actions in the practice setting, nor to explain their practice. This suggests that student nurses are not learning about the expected effects and side effects of drugs they administer, but tending to distribute drugs following prescription without taking responsibility for their action in considering whether the patient is responding as expected to the drug therapy. Clancy et al (2000) also surveyed staff nurses (n = 171), they reported a lack of overall confidence with knowledge of drug actions. This suggests a situation where students are unlikely to gain the knowledge they need about drug actions in the practice setting due to a lack of confidence in their mentors on this subject. Gresty and Cotton (2003), summarising the lack of application of bioscience to nursing practice, describe the use of an on line resource to embed the learning of bioscience in practice from the start of the programme of study. In their paper exploring collaborative working in the health care setting, Prowse and Heath (2005, p133) note their belief that nurses develop 'bioscientific knowledge' through work roles and that learning is likely to occur irrespective of teaching. Bradley et al (2006) describe the surprise amongst students on a Nurse Prescriber programme that the focus was on general principles rather than on specific examples related to each student's practice. The students were very keen to relate their learning to their own practice.

Studies suggest that not only is the bioscience taught in a way that divorces it from practice, but also the expectations of the registered nurses' knowledge are greater than the actual level of knowledge held. As far back as the 1970s Wilson's monograph (1975) identified a discrepancy between staff nurses' knowledge of biological sciences and doctors' assumptions of their knowledge. This was the first study to be conducted on biosciences in relation to nursing, no specific methods for such a study had been developed prior to this, although Wilson does cite the WHO (World Health Organisation, 1956) Regional Office for Europe indicating that 'criteria regarding the standard of knowledge of the biological sciences required by the practising nurse' lacked definition (Wilson, 1975, p33). The work carried out by Wilson is both major and significant. She first carried out observations in three hospitals, with four wards in each hospital covering 1800 hours and including

both days and nights over a six month period, observing registered nurses and students of nursing – she used these observations to identify nursing activities which required bioscience knowledge. Wilson then examined whether the bioscience knowledge underpinning the nursing tasks she had observed was evident by administration of an objective test to 532 registered nurses and students of nursing. The test items are provided in an appendix to Wilson's (1975) work.

Taking this one step further, she then showed the objective test to 179 medical staff from the same 3 hospitals, asking them to indicate which items on the test the doctors expected the registered nurse would know, and which they would not. The findings were clearly reported with substantial evidence to underpin her claims. Not only did Wilson demonstrate that doctors' assumptions of registered nurses' knowledge was higher than the level of knowledge actually held by the registered nurses, she also demonstrated a very substantial level of use of bioscience knowledge by nurses in direct patient care and in communication with other members of the health care team. This is a relatively old study, but is included in some detail here because of its size and significance.

Wilson only investigated nurses working in general medical and surgical wards in general hospitals. Her sample did not include mental health nurses or nurses working in community or GP settings. The results should not, therefore, be immediately generalised to nurses outside general hospital settings, but there is no reason to suppose that nurses in other settings, who had undergone similar training for nursing, would differ significantly from Wilson's cohort. Wilson's findings clearly support a continuation of a medical model, suggesting that nurses need the same range of bioscience knowledge as doctors but with less depth to their knowledge. She recommended an increase in the knowledge of biosciences amongst staff nurses but this did not appear to influence policy and practice in relation to curriculum development as within less than 10 years Project 2000 was being developed with a substantial reduction in the quantity of bioscience. There is no clear consideration of the reasons for this in the literature, however there is

suggestion that the power of the nursing lobby on curricular issues was held by those who lacked a bioscience background and sought to further move away from the medical model (Courteney, 1991; Trnobranski, 1993; Wynne et al, 1997). Deans et al (2003) discuss some of the background to Project 2000. Although they do not directly address causes for a move away from bioscience in the curriculum, they do refer to issues of the need to reduce wastage (reduce those leaving nursing courses) and to increase opportunities for women who may have childcare or other responsibilities – Deans et al (2003) do not suggest an easier course, but it could be argued that reducing bioscience content, and reducing the bioscience entry criteria, could assist in achieving these ends. However, Deans et al (2003) also identify the main aim of Project 2000 was to increase the theoretical components of nursing programmes and improve parity with other health care professions by moving the education into the University setting. There seem to be mixed messages here, on the one hand reducing the theoretical components by reducing bioscience (although increasing behavioural science input), but on the other hand aiming to increase the status of the qualification. The continuing complexity with quality assurance of diverse programmes due to a lack of a clear national curriculum suggests that this situation is ongoing and the move to university education did not in itself improve the appropriateness of nursing programmes for development of registered nurses (Thompson and Watson, 2005).

The relatively new role for nurses of prescribing drugs is again identifying the need for greater inclusion of a medical model in the preparation of nurses (Bradley et al, 2006). Bradley et al (2006) interviewed nurse lecturers to discuss training for prescribing and identified from these interviews that the experience of the nurses entering prescribing training is very varied as is their knowledge and their need to use bioscience. Bradley et al (2006) recommend the inclusion of adequate bioscience knowledge in these programmes, especially as related to pharmacology. The need to prepare the Nurse Prescriber to assess clients, make judgements about symptoms, read and interpret the formulary, and decide on a suitable prescription all fall within the boundaries of bioscience knowledge and suggest a medical model as

most appropriate (Courtenay, 2002). In their evaluation of the effectiveness and ongoing education of Nurse Prescribers, Latter et al (2007) surveyed 246 nurse prescribers by postal questionnaire highlighting the lack of pharmacology knowledge in the first groups of Nurse Prescribers. These authors also describe a lack of research into educational preparation for the Nurse Prescriber role and the need to explore the effectiveness of Nurse Prescriber programmes. Latter et al (2007) note the concerns of students in such roles about their lack of pharmacology knowledge. This appeared to be a particular challenge for district nurses and health visitors, who expressed concern about missing a diagnosis or writing an incorrect prescription. The study highlighted that during the Nurse Prescriber programme, students spent considerable amounts of study time developing their pharmacology knowledge, which they considered to have been inadequate on commencement of their Nurse Prescriber programme.

Mooney (2007), in her interviews with 12 newly qualified nurses in Ireland, reports the lack of pharmacology knowledge these nurses had. Mooney (2007) conducted her interviews with nurses who had been supernumerary during their pre-registration programme, similar to the situation in the United Kingdom since Project 2000, to explore aspects of the transition from student to staff nurse. The expectation of drug knowledge did not match the newly qualified nurses' actual knowledge; staff nurses lacked knowledge of drug action and drug procedures. There was also a sense of fear or significant anxiety associated with the lack of knowledge of pharmacology, with a real concern that a mistake may be made. The fear was particularly in relation to patient safety, that an error might harm the patient. Mooney (2007) notes that almost all the interviewees raised issues of lack of pharmacology knowledge.

The Australian study of pharmacology preparation of nursing students undertaken by Manias and Bullock (2002) used focus group interviews with 4 – 12 experienced registered nurses per group, asking for the views of these experienced nurses regarding the pharmacology knowledge of newly registered graduate nurses. Newly registered nurses were considered to have deficient pharmacology knowledge and a lack of relevant vocabulary to

use the material available to find out more about drug actions. A number of areas were identified where knowledge of pharmacology clearly linked to nursing practice, for example linking medication effects to patient symptoms and recognising adverse effects of medications. Newly registered nurses were considered to be deficient across most of these areas. The need to include pharmacology as a distinct area of the pre-registration curriculum and the need for ongoing clinical supervision after registration was highlighted by these researchers.

Since Wilson's (1975) publication, Jordan and Hughes (1998) and Eraut et al (1995) have studied qualified nurses in the workplace, identifying that biosciences are indeed used by qualified nurses and that completing a post registration course in bioscience gave nurses an increased perception of competence. Eraut et al (1995) undertook a large study and used interviews with registered nurses to produce knowledge maps after finding that there was no established methodology to identify what scientific knowledge was relevant to practice, here scientific knowledge included biological, behavioural and social sciences. This thorough study included: interviews being undertaken with 6 – 10 nurses from each of three areas of practice; a series of three case studies of programmes of study in preparation for nursing or midwifery; and four mini studies of different aspects of work based and classroom based bioscience knowledge. This was one of the Research Reports Series for the English National Board for Nursing, Midwifery and Health Visiting (ENB), (one of the four National Boards subsumed under the current regulatory body the Nursing and Midwifery Council). Eraut et al (1995) mapped practice relating to bioscience knowledge in five areas: acute pain; fluids, electrolytes and renal systems; nutrition; shock; and stress. As well as recommending further work on knowledge mapping, Eraut et al (1995) also made curriculum recommendations. Two of these, improving arrangements for support of learners in placement and specifying the level of competence expected of a newly registered nurse, have been taken up by the NMC and the current 'Standards' documents relating to pre-registration nursing and to learning and assessment in practice demonstrate this (NMC, 2004 and 2006c) – however, neither of these deals with bioscience. The

other two curricular recommendations were the need to sequence content appropriately and to co-ordinate theory and practice learning more effectively. Specific recommendations for biosciences here are the need to ensure the student has a basic knowledge of bioscience before going to placement so that the student does not appear 'totally ignorant' (Eraut et al, 1995, p107) and to deliver the theory of bioscience in relation to specific placement experience. Neither of these last two recommendations have been taken up by the NMC, instead this has been left to individual Universities to implement if they wish. No systematic further work has been undertaken on knowledge mapping for nursing, although it could be argued that the NHS Knowledge and Skills Framework (KSF) (DoH, 2004) could be used for this purpose. Mapping of job roles to the KSF is currently being undertaken within the NHS.

Jordan and Reid (1997) carried out an action research study examining the impact on patients of post registration teaching of biosciences to nurses. A single cohort of 52 nurses entering a post-registration Diploma in Nursing was purposefully selected for the study. Eight students withdrew from the programme, only one declined to participate, leaving a sample of 43. Their findings suggest that patient care is improved by better application of biological knowledge. The researchers looked at diaries produced as part of the academic assignments for the programme of study, as well as information generated by administration of questionnaires and through focus groups. Incidents were identified by the students to try to demonstrate where recently gained bioscience knowledge was considered by them to have contributed to improved patient care. Many positive effects were reported, for example improved ability to review protocols for care, and improved ability to undertake patient education, with the overall conclusion that the nursing students had gained greater understanding of interventions and could then communicate more effectively with the patient about the intervention. A criticism of this study is that the researchers were also the lecturers of the students, and possible power relationships were not considered in analysis of the results. Tarling (2002, p122), discusses the powerful position of the researcher in relation to patients. A similar power imbalance exists between students and lecturers, even when the students are professional nurses. It is

possible that the nurses wanted to provide information that they considered the researchers (their lecturers) desired; the lecturer was going to be marking the assignments and determining whether the nurse passed or failed the course. The nurses may have been reluctant to provide information that conflicted with the researchers stance, as this may have been perceived by the nurses as affecting their academic results. Discussion of the potential power relationships, as recommended by Cohen et al (2000), would have contributed to an increase in the validity of this study. Despite this criticism, the study does appear to meet Bassey's (1999) criteria for validity in representing what it claims to represent as it does actually report the applications of knowledge of physiology to the role of the nurse in practice and is grounded in the participants' experience. Research ethics committees seek to ensure that practices are in place to avoid coercion by the researcher, this avoidance of coercion is referred to (one nurse declined to participate) but not directly addressed in Jordan and Reid's (1997) study.

Although, as identified by Draper and Clark (2007), research into the effectiveness of CPD is limited, Considine et al (2007) undertook a study in Australia of 88 emergency nurses. Their findings demonstrated increased knowledge and improved clinical practice in relation to use of oxygen administration devices.

Jordan et al (2000) undertook a rare study examining bioscience knowledge related to mental health nursing. Other studies have focussed on the biological knowledge related to general nursing. This comprehensive study evaluated surveys from 354 nursing students and 73 of their lecturers. In addition, community mental health nurses were interviewed and these interviews analysed. The study was not only unusual in looking at mental health nursing; it was also unusual because it included interviews and focus groups with service users (patients). The study clearly identified a discrepancy between the expectation from service users of mental health nurses' knowledge of pharmacology, and the actual knowledge of pharmacology the nurses possessed, which was lower than the expectation. An additional finding from this study identified that the bioscience in the early

part of the pre-registration nursing programme, which was shared with general nursing students, lacked relevance to mental health service settings. A survey of universities in the UK by Morrison-Griffiths et al (2002) identified considerable differences in pharmacological content of the pre-registration nursing curriculum and a lack of sufficient content.

Professional knowledge

The ways in which nurses use their knowledge in their everyday work has been discussed above. Relevant literature concerning the notion of 'professional knowledge' is now briefly explored. The main themes emerging relate to the confidence with which knowledge is held and used in the work setting – with a clear thread that experience assists in developing confidence in the knowledge held and this has a positive impact on professional practice. Before exploring this theme of confidence, brief mention is made of the difference between nurses who are competent and those who are knowledgeable practitioners. This is an area for discussion in nursing, particularly in relation to the increase in use of health care assistants to undertake tasks traditionally performed by nurses (Hinchliff et al, 2003). Health care assistants undertake National Vocational Qualifications (NVQs) that have competence based assessment systems (Quinn and Hughes, 2007). Obtaining an NVQ is recognition that the individual has demonstrated a competent level of practice in a number of skills and 'competence' has come to be a term associated with skills based training (Quinn and Hughes, 2007). It is used to indicate that an individual can be judged competent in a task without reference to the excellence of performance of that task. Hinchliff et al (2003) state that the competent individual 'possesses the skills and abilities to practise safely without direct supervision' (p104). This is also the meaning of competence used by the NMC (2004). Nursing considers itself a profession, and considers that both education and skills based training are important elements of preparation (Ash, 2006). This means that competence is important, but that the level of professionalism expected of a nurse is greater than the level of being competent in skills (NMC, 2004).

The NMC Standards of Proficiency for Pre-registration Nursing Education (2004) indicate that newly registered nurses must be fit for purpose; Quinn and Hughes (2007) identify this as a measure of competence to perform in role. The notion of competence suggests training to perform tasks, and this is clearly an important aspect in nursing. However, the NMC Standards (2004) also state the newly registered nurse must be fit for award, Quinn and Hughes (2007, p354) equate this to a 'breadth and depth of learning', a nurse educated to a level of knowledge and understanding deemed appropriate for the qualification. In a paper arguing the important role of the Higher Education Institute (HEI) in nurse education, Watson (2006) claims that nurses, as a group, do not always recognise the significance of this higher-level knowledge and suggests nurses are not 'capable' (p622) if they are only competent. He argues for the significant role of the HEI in enabling nurses to be adaptable and able to use their competence in a variety of settings including those that the nurse has not previously been exposed to or prepared for – this is development of capability. The NMC refer to this aspect in their use of the terms 'fitness for purpose' and 'fitness for award' (NMC, 2004, p14) indicating that being able to perform skills is insufficient, being able to adapt to different situations and work in complex settings with competing demands is also required. Some of the earlier studies discussed in relation to bioscience in nurse education (Clancy et al, 2000; Jordan, 1994; Courteney, 1991) suggest that the curriculum did not always acknowledge that nurses should be knowledgeable practitioners, and concentrated on preparing students for roles which were at the level of competence rather than at the level of capability.

Eraut (1997) suggests that professional knowledge takes two forms, public propositional knowledge and personal knowledge. Public propositional knowledge in the biosciences for nurses includes textbooks and lecture notes as well as informally acquired knowledge such as experience in the workplace. Personal knowledge is that which the practitioner understands and uses in their work. This personal knowledge may be tacit or explicit. The explicit knowledge is understood well enough to be communicated to others (for example during an emergency communicating vital signs, responses to

treatment and discussion of appropriate courses of action occurs between a number of professionals) whereas tacit knowledge is such that practitioners are unable to communicate what they know. For example, a registered nurse may be able to record an electrocardiograph and recognise that the trace shows abnormality, without being able to state what that abnormality is – perhaps because the nurse does not feel confident in their knowledge or because they do not know or feel confident in the language needed to communicate the abnormality (Clancy et al, 2000). A measure of explicit knowledge is useful for professional development of the individual. Explicit knowledge indicates that the individual is not only performing skilled behaviours but is also able to reflect on and change practice using that knowledge (Eraut, 1997). Benner (2001) refers to this as moving further along the continuum from beginner or novice (newly registered nurse) towards expert practitioner status (the practitioner who is able to use knowledge effectively and provide a detailed rationale for nursing practice). Her 1984 study of both newly registered nurses and experienced nurses was designed to identify differences in approaches and priorities, and the rationale for their actions (Benner, 1984). Benner's study identified the need for the novice to be conscious of the rules to guide practice, whereas the advanced beginner, with appropriate guidance from supervisors, will be able to gain experience to broaden the application of the rules. Benner found that it is only after the advanced beginner stage that the nurse could be considered competent, able to make decisions about the work independently of supervisors. With further experience, Benner describes that nurses were able to move to a state of proficiency and then expert status. Her highly regarded work examines the underpinning knowledge related to nursing practice, and the development of nursing skills to a higher level. Benner (2001) is particularly concerned to use clinical narratives for periods of reflection in order to embed knowledge and understanding in practice. Her work is identified by Quinn and Hughes (2007, p371) as 'one of the most frequently quoted research studies in nurse education'. This was the first study to consider the complexity of learning in the nursing profession, developing theoretical knowledge but using that knowledge in clinical settings, and opened the debate for consideration of how expertise develops in the clinical

setting. In studying the confidence with which nurses hold their bioscience knowledge, aspects of Eraut's (1997) and Benner's (1984) work need to be considered, that is, to what extent is the level of experience the key player in the bioscience confidence of the nurse? Prowse and Heath (2005) also ask for further research into 'non-formal, work-based learning taking place in practice contexts' (p134) indicating that most of the existing literature about bioscience in nursing has focussed on formal learning.

While not directly related to nursing, a year-long study about informal learning in a professional setting is worthy of note. In their paper about teachers and secondary school classroom teaching in the Netherlands, Hoekstra et al (2007) explore how teachers learn informally by doing the job of teaching. They define informal learning as being separate from formal teaching or continuing professional development and occurring by doing the job. The authors identify that informal learning may occur consciously or unconsciously and the paper endeavours to describe the activities through which informal learning occurs. Hoekstra et al (2007) distinguish between the motivators for formal and informal learning, with the latter being specific work based goals, occurring to solve real problems, rather than merely learning goals. They separately describe three forms of informal learning based on Eraut's (2004) summary. Deliberative learning is conscious and planned and occurs to purposefully solve problems. The authors describe the importance of intentional practice in deliberative learning; that is, thinking through a problem and deciding on a different and deliberate course of action. Reactive learning is described as also occurring consciously but in an unplanned way, to deal with issues immediately as they arise in practice. Hoekstra et al (2007) report the role of monitoring in this type of learning, describing the way in which teachers regularly react to classroom events and modify their strategies in the classroom to meet their desired aim. The suggestion here is that teachers engage in critical practice, requiring ongoing consideration of the teaching and learning as it is occurring, with modifications being introduced as a session progresses. This type of learning appears to be what Schön (1996) described as reflection-in-action, discussed under adult learning below. Implicit learning on the other hand describes unconscious learning, giving rise

to the equivalent of Eraut's (1995) tacit knowledge. The research by Hoekstra et al (2007) suggested that this type of learning occurred through repetitive action or repeated experience. They note that their findings for deliberative, reactive and implicit learning are not currently accounted for in the theory of how teachers learn. Hoekstra et al (2007) state that Eraut (2004) does not give any empirical research to support his main arguments on the nature of informal learning and suggest that their own work is the first to do so. Further research activity is clearly indicated in this area.

Eraut (2004) summarises findings from several research projects concerned with learning at work, although most of these are not specific to nursing. He suggests that most learning at work is informal, occurring through interaction with others and through individual experiences. He also notes that 'most workplace learning occurs on the job' (Eraut, 2004, p249) rather than in the classroom. Eraut specifically states that learning from a mentor is not informal learning; even though it is workplace learning it is considered to be more structured and planned than informal learning. Eraut (2004) also communicates findings from Eraut et al's (1995) study of nurses and midwives, indicating that it is now clear to him that the ability to 'transform' knowledge and skills 'to fit the new situation' (Eraut, 2004, p256), or to integrate these with other learning, is not taught in the higher education setting or the workplace setting. The implication for nursing is that something is missing in the education of nurses – the suggestions from Eraut (2004) do not appear to have been taken up by the nursing literature in recommending changes to the way in which nurses learn bioscience.

Adult learning theory

Nursing students are all 18 years old or above, with an increasing number of older students now commencing nurse training and a current average age in the late 20s (Ball and Pike, 2005). A short exploration of the literature on adult learning theory has been undertaken in relation to adult students of nursing. The purpose of this is to identify aspects of adult learning that may impact

upon the nursing student's ability to learn and become confident with bioscience knowledge.

A variety of theories of learning have been developed. These include behaviourist theory, Gestalt theory, cognitive theory and humanistic theory (Quinn and Hughes, 2007; Reece and Walker, 2000). The behaviourist models identify the stimuli needed to promote learning, the role of conditioning and the use of reinforcement and feedback in learning. Gestalt theorists emphasise the importance of structure and pattern in providing the learner with the opportunity to gain understanding. Providing the whole picture so that the student can place the information within a structure is emphasised, as is the importance of grouping similar elements and providing time for the student to understand in relation to their individual experience (Reece and Walker, 2000). Cognitive theorists are concerned with the mental processing of information that occurs as learning takes place, they emphasise the greater importance of the learning process compared to the knowledge learned. The main theoretical approach to adult learning, however, is humanistic (Quinn and Hughes, 2007).

Considerable literature exists about how adults learn, taking account of their experience, their motivation, their developmental phase and their level of independence (Quinn, 2000). For example, Rogers (1983) discusses adult learners as being in need of facilitators of learning rather than teachers. Kolb (1984) identifies the importance of experience in learning. He developed an experiential learning model to demonstrate the learning that occurs as an individual thinks about and reflects on an event. The use of reflection has indeed taken hold in nursing education, although Quinn and Hughes (2007) point out that Kolb's model lacks empirical support. Knowles (1996) and Knowles et al (2005) place emphasis on the learner's need for self-development and the content being learned according to the student's need, with the teacher assisting in the process of learning. This literature refers to the assimilation of knowledge as students start and continue on courses. These authors come from the humanistic group of theorists and purport that learning is about experience, with the learner being an independent,

motivated and self directed being who can use their own experience as a significant resource for further learning (Armitage et al, 2003). This notion of adult learning takes into account Mezirow's (1997, p6) concept of 'transformation theory', that is, adults perceive through a frame of reference that gives meaning to learning. This suggests that adults learn best when learning relates to something they are familiar with.

Driver (1988), Driver and Bell (1985) and Linn and Songer (1993) discuss the importance of secondary school students' prior learning in acquiring knowledge and understanding of science. Students may have learned something that is not correct, or have negative attitudes to the material, and this prior learning needs to be addressed before new learning can occur. These authors are clear that students are active learners who learn in relation to their individual knowledge and experience. Dart (1997, p30), uses the term 'constructivist learning theory' to account for adults selecting knowledge which relates to their existing knowledge and current needs, that is they 'construct' new knowledge based on their own life experience and current situation. The earlier literature identified under bioscience in nurse education demonstrates a lack of grounding in practice for bioscience teaching (Courteney, 1991; Jordan, 1994; Eraut et al, 1995; Davies et al, 2000) – adult learning theory suggests that this theory-practice link is essential for older learners. It would appear then that the nature of the student is not being considered in delivery of the bioscience curriculum. With all nursing students being adults, the teaching should be making use of real clinical situations to develop learning of the biosciences, fully embedding the theory in practice. The studies on nurse education for bioscience also demonstrate that teaching methods tend to be by lecture, whereas students prefer less didactic and more facilitated learning (Davies et al, 2000; Clancy et al 2000; Wynne et al, 1997; Wharrad et al, 1994) – adult learning theory suggests that adult learners need to have time for reflection (Kolb, 1984), time to discuss content in relation to experience (Dart, 1997; Knowles, 2005), and the chance to learn in a style which suits them personally (Mezirow, 1997). Eraut et al (1995, p113) emphasise that 'learning from experience' by reflecting and discussing with other students and with lecturers should be given at least as much

emphasis as the original content. The authors identified above indicate that the process of reflection should be critical, identifying what knowledge is used, why it is useful, and how it is used, and identifying gaps in the knowledge base. The need for programmes of study to help the student to learn how to learn, including the use of critical reflection, is one of the implications for teaching identified from Eraut et al's (1995) study.

Schön (1996) explains the way in which professional groups developed 'technical rationality' (p12) using scientific knowledge and applying it to human settings. He argues that this was less than satisfactory, because humans are complex and dealing with the human condition means dealing with uncertainty. He recommended a move to greater exploration of problem identification rather than problem solving, and coined the phrase 'reflection-in-action' (Schön, 1996, p19) to describe a more professional way of working. This form of reflection appears to be what Hoekstra et al (2007) are referring to when describing reactive learning, being able to think about the situation as it is occurring, identifying what is happening, whilst at the same time adjusting behaviour to improve the likely outcome.

Some aspects of the literature on adult learning theory are, arguably, applied to teaching practice in nursing (Quinn and Hughes, 2007). For example, aspects of bioscience are embedded in examples from practice and the lecturer does act as facilitator in some types of teaching activity. However there is still a considerable divide between the university theoretical element and the clinical placement element of learning. The concept of the lecturer as facilitator could be used in the clinical setting more strongly – with lecturers making use of the clinical situation to develop students clinical reasoning skills and skills of critical analysis.

Summary

In summary, a number of themes have emerged from the literature. Studies identify that nurses' bioscience knowledge is variable both before entry to a training programme and on qualification (Trnobranski, 1993; Jordan, 1994; Clarke, 1995; Wynne et al, 1997; Courteney, 2002.) Both the inadequate provision of teaching, and the reduction in the proportion of the curriculum

allocated to bioscience are identified as causative factors for the variability of bioscience knowledge in the registered nurse. A sense of competition between inclusion of the behavioural sciences and the biosciences is clearly visible in the literature, with lecturers appearing to favour the behavioural sciences. Variation in content of programmes between institutions is also evidenced (Wharrad et al, 1994). Other authors draw a link between deficiency of bioscience knowledge and bioscience teaching, identifying that what the students believe they need is greater in breadth and depth than what they receive as bioscience teaching (Wynne et al, 1997; Davies et al, 2000; Jordan et al, 1999). Additionally, the literature demonstrates a lack of linking between theory and practice for bioscience teaching (Courteney, 1991; Jordan, 1994; Eraut et al, 1995; Davies et al, 2000).

Other literature demonstrates a reduction in the knowledge of bioscience held by nurse lecturers (Hayward and Akinsanya, 1982; Courteney, 1991 and 2002; Clarke, 1995) and a lack of confidence in the bioscience knowledge held by registered nurses. This lack of confidence appears to have been transmitted to nurses during their training, with registered nurses emerging as lacking confidence in their bioscience knowledge (Jordan and Hughes,1998; Eraut et al 1995). Some have tacit knowledge (that is knowledge which they appear to use in the practice of skills but cannot easily articulate) but not explicit knowledge (that is they are unable to communicate using the language and concepts of this knowledge), (Eraut, 1997).

Finally, it is clear from the literature on adult learning theory that adult learners, including students of nursing, need knowledge to be relevant to their work and developed using their experience. This is evident through the literature on adult learning and the studies of registered nurses and nursing students. Furthermore the importance of reflection in enabling learning, and adapting learning to the range of learning styles, is evident in the literature (Kolb, 1984; Schön, 1996; Boud et al, 1996; Mezirow, 1997; Dart, 1997; Knowles, 1996; Knowles et al, 2005; Kevern and Webb, 2004).

The emerging themes from the literature suggest that students of nursing undertake a programme of study that does not, in terms of bioscience knowledge, prepare them adequately for their roles as registered nurses. Key elements of this are the lack of bioscience knowledge of nurse lecturers, the lack of application of bioscience knowledge to the nursing setting when it is being taught, and the more positive views held of the importance of biosciences by nursing students when compared to nurse lecturers. The literature on professional knowledge suggests the importance of embedding any theory in practice; this is also the emerging theme for the literature on adult learning theory, which suggests adults learn best by relating the new knowledge to existing experience.

3. Research Design and Methodology

Research aims and objectives

The study aimed to explore registered nurses' perceptions of their own bioscience knowledge and the ways in which this knowledge had been gained. The participants were drawn from three cohorts of students on Nurse Prescriber programmes undertaken at one University. The objectives were to identify the students' level of confidence with bioscience knowledge and the ways in which this knowledge had been obtained. It was hoped to develop an increased understanding about the relative importance of prior knowledge, initial nurse education, clinical experience and interest in relation to the bioscience knowledge held by the individual nurse. While the study generated mainly qualitative data, some quantitative data gathered in relation to the participants lent itself to numerical analysis. For example, analysis of the age profile, year in which qualified, number of years in nursing, and use of adverbial/adjectival scales (Sim and Wright, 2000) to identify perceived usefulness of previous qualifications is analysed with descriptive statistics using the frequency and cross tabs functions of SPSS.

Research design

Much educational research comes from an interpretive paradigm. That is, rather than trying to establish cause and effect, the research is endeavouring to describe the subjective experience of those in educational settings (Cohen et al, 2000). Studies from educational settings in general and those with a health focus in particular have often used action research, ethnography, or phenomenology within an interpretive paradigm, this enables individual experiences to be explored and a richness of research material to be acquired (Denzin and Lincoln, 2000; Burns and Grove, 2001). Where studies are trying to examine cause and effect, and particularly where large cohort studies are undertaken, quantitative methods are often appropriate (Cohen et al, 2000). In this way, large amounts of numerical data can be statistically analysed to determine the probability of associations occurring by chance. However, this research topic is concerned with trying to explore the

experiences of nurses and seeks to identify different individual experiences within a group of nurses and therefore lends itself to an interpretive paradigm with an in depth analysis of the topic using a qualitative approach. A number of qualitative methodologies are available (Sim and Wright, 2000). Those methodologies that are frequently employed in the studies of nurse education include: phenomenology, most studies in phenomenology in the area of nursing or nurse education deal with feelings or experience of disease or professionalism (Speziale and Carpenter, 2007; Kleiman, 2004; Priest, 2004); ethnography, the emphasis of ethnography is behaviour, and an examination of the situation or context of that behaviour, including symbolism and aspects of culture (Punch, 2005); symbolic interactionism, which is concerned with the subjective understanding that participants give to their experiences (Cohen et al, 2000); action research, a group activity producing knowledge to support change (Speziale and Carpenter, 2007) used to evaluate current practice and to solve a current problem (Punch, 2005); grounded theory, to produce generalisable theory where none exists (Strauss and Corbin, 1990, 1998; Punch, 2005; Charmaz, 2006; Benoliel, 1996); social constructionist approaches including discourse analysis focussing on the written or spoken word and an analysis of this (Potter, 1996; Gill, 1996; Seibold, 2006); and case study (Eisenhardt, 2002). Case study was the approach selected for this research, the reasons for this are explained below.

This study endeavours to explore individual cases (Nurse Prescribers), giving a depth and richness to create pictures of a variety of nurses and their perceived knowledge, and how this knowledge has been acquired. Miles and Huberman (1994, p24) identify this as 'non-causal research'. That is, it is exploratory and endeavours to discover nurses' perceptions of their biological knowledge, how this knowledge was acquired and the degree of confidence with which it is held. The study is not specifically looking for cause and effect relationships, and the findings are not likely to be fully generalisable. They will relate to the group studied. However it is hoped that 'fuzzy generalisations' will be possible which enable application of findings to a wider group than the participants in the study (Bassey, 1999, p14). Bassey uses this term to encompass those statements from the findings of the study that could be applied to groups other than the group under investigation in the

study, in this case some statements of findings may be at least partly applicable to other Nurse Prescribers, or to the wider group of registered nurses. The concept of 'fuzzy generalisations' (Bassey, 1999, p14) is discussed further below. It is anticipated that ideas for further research will develop from this study – for example it would have been possible to take a sample of newly registered nurses, or to use experienced nurses, or a mixed sample for this study, it may be appropriate to investigate other nursing groups apart from Nurse Prescribers.

However, given the relatively new role of Nurse Prescriber and the lack of research into this role, and the requirement for nurses undertaking this qualification to have three years experience prior to starting, only those nurses starting the Nurse Prescriber qualification were invited to participate in this study. These nurses were all deemed by their employers to be experienced nurses. Studying this group enabled nurses from a range of job roles and clinical areas to be included, including for example community matrons, clinical nurse specialists and senior staff nurses from both general and mental health settings. Whilst there was a clear advantage in studying this group (a cohort that is diverse but considered to have sufficient experience in relation to their role) there are also potential disadvantages. One of these is the fact that many experienced staff nurses in hospital settings work with patients who are physically ill, but this group may not be seconded to undertake the Nurse Prescriber qualification because sufficient medical staff are available to undertake prescribing. This was taken into account when considering how generalisable the findings are – that is, it was important to specifically consider whether this group could be included in a 'fuzzy generalisation' of the findings of the study (Bassey, 1999, p19). It was important to recognise that the nurses in this study from community, general practice and hospital bases may not be representative of the whole population of nurses in these areas at the same level of experience. The bioscience knowledge of nurses who are considered experienced, but do not undertake the Nurse Prescriber qualification, has not been investigated in this study.

Case study

Bassey (1999) advocates the use of case study research to help to develop a wider knowledge base than is possible using some of the other qualitative methods. Eisenhardt (2002, p8) describes case study as 'a research strategy that focuses on understanding the dynamics present within single settings'. A variety of data collection instruments can be used to describe a phenomenon or to test or generate theory. Eisenhardt suggests (2002, p31) that it is appropriate to use case study research to 'generate theory' where little background knowledge exists for a particular phenomenon. Clearly identifying the sample, and being selective about the inclusion of participants, that is using purposive sampling, can generate useful theory which further studies can elaborate. A case can be an 'individual, group, institution or community' (Gillham, 2000, p1). Here the case is nurses undertaking a Nurse Prescriber qualification.

Yin (1993, p5) identifies three main approaches to case study, 'exploratory, descriptive or explanatory'. The exploratory approach is used to define questions or hypotheses for further study, whereas the descriptive approach gives a full description of the case in its context and the explanatory approach links effects to causes. Other authors disagree with this stance, seeing the explanatory view as too positivist, in seeking to identify cause and effect (Bassey, 1999). Bassey (1999) reviews the different meanings of the term 'case study' and lists a number of authors who have developed their own structure and terminology for case study research, drawing out the strengths of each. He stresses that case study is useful in theory generation, and that such theory may be generalised within the study group, or to similar cases.

The lack of generalisability of case study findings has been a major criticism of the case study method (Bassey, 1999; Punch, 2005) and Bassey himself has moved from a stance of believing that case study findings cannot be generalised to one where he believes some generalisation is possible. Lincoln and Guba (2000) argue that generalisation is not possible from any qualitative research. In discussing case study research, Lincoln and Guba (2000) argue that the lack of clear boundaries identifying the extent or

limitations of case study research make generalisation impossible. The number of authors discussing the generalisability of case study research demonstrates the lack of agreement on this matter, although there is an increasingly held view that some generalisation is possible from case study research (Gomm et al, 2000).

Bassey (1999, p14) discusses 'fuzzy propositions' or 'fuzzy generalisations'. These are statements of findings given without statistical details, which nevertheless can be applied in a more general sense than to the specific cohort being investigated. The statement 'BEd students are likely to perceive Education Studies as facilitating their teaching competence' (Bassey, 1999, p19) is given as an example of a fuzzy proposition. In this example, Bassey has made a carefully worded statement of expectation, of how a finding from a specific setting can be transformed into an expectation for a more generalised setting. Bassey (2001b) distinguishes fuzzy generalisations from scientific generalisations, with the former having less certainty and being less specific than the latter. He explains that scientific generalisations are made in relation to 'few significant (defined) variables' (Bassey, 2001b, p6) whereas fuzzy generalisations are made in relation to a larger number of, and often undefined, variables. Providing there is enough data and that the data are used to underpin the arguments made, case study can be a very effective methodology. In his presentation to the BERA symposium Bassey (2001a, p7) stresses that 'we must not be fuzzy with the truth'. He argues that the exact findings from case study should be clearly set out, and separated from any generalisations so that it is clear what has been found for the case being explored, and what this could mean for the wider population. Bassey (2001a, p7) recommends 'making a best estimate of trustworthiness' by considering the application of knowledge in other practice settings. He is keen to see fuzzy predictions set out clearly and in such a way that lecturers can make use of them in improving their practice.

Fuzzy generalisations and fuzzy predictions are made for this study. Fuzzy predictions are seen by Bassey (2001b) as fuzzy generalisations that can make use of other research in the field to predict the other situations to which

the findings from the study are applicable, that is to more clearly articulate the generalisation, and possibly reduce the fuzziness. For the current study, other research is evaluated and synthesised to determine the extent to which it can inform a fuzzy prediction.

Case studies allow for the use of mixed methods and these are recommended by many authors (Bassey 1999; Punch, 2005; Gillham 2000). The advantages of using mixed methods are to draw together information using a range of tools so that the strength of the argument is more clearly visible and to obtain a 'synergistic view of the evidence' (Huberman and Miles, 2002, p7). Yin (2003) identifies that the richness of the context of a case is better explored by use of mixed methods of data collection so that different elements are more likely to be demonstrated. Bassey (1999) stresses the importance of developing a wide knowledge base to develop theory and supports the use of mixed methods of data collection.

A case study approach matched most closely with the aims of the present study and is the one that was adopted. In an attempt to gain a picture of the whole group of students, and to triangulate, with a sense of how representative the case study sample was, a short questionnaire was administered to all participants. This generated both quantitative and qualitative data. This is further discussed below. Eraut et al (1995) used interviews and case studies to identify explicit knowledge of registered nurses. Interviews with students on Nurse Prescriber programmes were used to elicit their responses to the research questions. This generated qualitative data. The choice of interview structure and discussion of this is given below.

Trustworthiness

Triangulation

Cohen et al (2000, p112) define triangulation as 'the use of two or more methods of data collection in the study of some aspect of human behaviour'. This enables the researcher to check results obtained and can help to contribute to the reliability and validity of the research study. However, it

should not be assumed that using more than one method for data collection, that is methodological triangulation, would result in greater reliability. Laws et al (2003) discusses methodological triangulation and point out that different results may occur from different methods, and that these would need to be analysed. Yin (1993, p97) believes it is important to use 'multiple sources of evidence', and Gillham (2000, p2) records that use of 'multiple sources of evidence (is) characteristic of case study research'. However Denzin and Lincoln (2000) argue that triangulation is rather limiting for qualitative research and should be considered as an alternative to validity. There is a concern that some of the uniqueness of the data collected by qualitative research could be lost in the struggle for triangulation. For example, the data gained in an interview may be much richer than that gained by a questionnaire, and the findings from the questionnaire may not be able to support the findings from the interviews because they lack depth. Richardson (2000, p. 934) recommends instead the acknowledgement of 'crystallization' within qualitative research, that is, acknowledging the many different facets involved in this type of work and clearly articulating these. For case study research there are 'no recommendations to triangulate' methods, data, investigator or theory (Janesick, 2000, p391-2). The recommendation is rather to ensure that 'the theory-building process is so intimately tied with evidence that it is very likely that the resultant theory will be consistent with empirical observation' (Eisenhardt, 2002, p29). Bowling (2002) identifies the importance of the investigator being rigorous in their interpretation of the data and avoiding the use of 'selective perceptions' (Bowling, 2002, p404) to ensure trustworthiness. In this study the questionnaire was used to generate additional information about the topic, and interviews were used to gain a deeper understanding from some participants, thus some triangulation of methods was used. There has been a real emphasis on integration between data and theory for the current study, and an avoidance of being selective in the perception of the data or trying to analyse the data too early.

Reliability

'Reliability is the extent to which a test or procedure produces similar results under constant conditions on all occasions.' (Bell, 2005, p117). Strauss and

Corbin (1990, p250) explain that ‘no theory that deals with a social/psychological phenomenon is actually reproducible’ because although the main conditions may be reproducible the individual characteristics of the respondents and their circumstances will not be reproduced. Miles and Huberman (2002) imply that the richness of the study is a keystone of qualitative methodologies but that this separates them from the quantitative studies to which scientific reliability can be applied. Strauss and Corbin (1990, p251) use the notion of reproducibility in a more general sense in relation to the ‘theoretical perspective’, the ‘rules’ regarding data and the ‘similar conditions’. They state that if other researchers follow these broad principles, the specific aspects of the study will not be needed in order to reach similar explanations. To increase reliability using a case study approach, it is essential to precisely state the theoretical perspective, to lay down exactly how data are collected and analysed, and to state clearly the sample and tools used (Bassey, 1999). This requires the researcher to be transparent in reporting how the research was carried out, with sufficient detail to enable readers to understand the limitations of the research. The current study is presented in considerable detail to increase this transparency, and to make it easier for other researchers to identify the way in which the study was undertaken. The questionnaire is provided (appendix A) and the way in which data were collected and analysed is described in detail below. Yin (2003) also recommends the use of a case study protocol to increase reliability of case studies. The importance of openness in declaring the purposive sample used and stating whether the sample is considered representative or not, will enhance the reliability of the study, the selection of the purposive sample and details of participants has been presented in some detail below.

Validity

Cohen et al (2000) describe the numerous forms of validity in current usage. They state that ‘in qualitative data validity might be addressed through the honesty, depth, richness and scope of the data achieved’ (p105). They recognise that all qualitative data display some bias because it is impossible (and sometimes undesirable) to ensure that the researcher is completely

detached from the research, so that 'absolute validity' is not possible (p105). It was important for this piece of research that any bias was clearly articulated. Acknowledgement of any bias enables findings to be interpreted more openly and those who seek to apply the new theory will be able to do so within the parameters of that theory. Punch (2005, p253) suggests that for qualitative studies, the question 'how well do the data represent the phenomenon for which they stand?' should be answered to indicate the validity of the study. The study must represent what it claims to represent; and be understood by the participants in the study (Bassey, 1999), that is it must be recognised by them as representative of their experience. If the theory is applicable to a number of situations beyond those immediately studied these must be clearly identified.

Miles and Huberman (2002) argue that internal validity of a case study is established if underlying reasons for relationships between data is given at the analysis stage. Systematically following data collection and analysis methods will assist in ensuring this occurs. This includes giving time to look at all the data before conclusions are made (Gillham, 2000). Gillham (2000) recommends presenting the case study as a narrative, with evidence woven in to 'develop and direct' the narrative (p22). The importance of looking for data that does not fit, and trying to take a step back and consider whether the researcher's own preconceived ideas are being used are stressed as useful ways to improve the validity of the study (Gillham, 2000). In the current study, particular care was taken to avoid drawing conclusions until considerable amounts of data had been gathered. This reduced the chances of the researcher's own pre-conceptions influencing the conclusions. In addition, the emerging themes were checked to ensure these were embedded in the data. The data were also rechecked to look for themes that had not been recognised at the first analysis. The results have been presented in narrative form, interweaving the data from the questionnaires with data obtained from the interviews. Bassey (1999) stresses the importance of obtaining enough data to explore and interpret the case, so that the story of the case study is recognisable to the participants and worthwhile as a piece of research. For the current study, considerable quantitative data were obtained from the

questionnaires and data were collected by interview and used in analysis of the themes, generating sufficient data for useful study.

Ethical issues

Any proposed or actual research may lead to issues of concern in relation to ethics. When researching with human participants, particular attention is needed to ensure that subjects are not deceived or exploited, and that their dignity as a human being is not undermined, treating participants fairly without undue burdens being applied (Sim and Wright, 2000). These are the principles of justice and respect for autonomy and the person. Equally, research should aim to be of benefit and it should not harm either the participants or others. These are the principles of beneficence and non-maleficence (Sim and Wright, 2000). To ensure ethical principles are adhered to, institutions have policies and procedures for ethical approval of proposed research studies. The researcher takes the responsibility of ensuring that ethical principles are fully applied to research undertaken, and demonstrates this through the process of ethical approval. In this study, the researcher was rigorous in the application of ethical principles.

Before undertaking this research, a formal application for approval of the study was made to the researcher's employer through the Research Ethics Committee. This is essential to ensure participants are not unwittingly recruited into large numbers of studies, and to ensure that practices undertaken in research projects are ethical and do not seek to exploit or endanger others. The British Educational Research Association has published 'Ethical guidelines for educational research' (www.bera.ac.uk/publications/guides.php, 2004). These guidelines identify that educational research must respect the participants within the study as well as 'the knowledge, democratic values, the quality … (and) academic freedom' (p5). Students are not obliged to participate in the research, but may feel obliged due to the request coming from one of their lecturers. It was essential to make clear to the students that there was no obligation upon them to take part and there would be no penalty if they chose not to take part.

This aspect related to the ethical principle of autonomy, respecting the 'self-determination of others' (Sim and Wright, 2000, p42). It is a requirement of the researcher's employer that permission for research must be sought and obtained before collecting any data. This permission was sought and has been given and the relevant forms are enclosed as Appendix D, E and F.

Participants were asked to read an information sheet outlining the purpose of the research (see Appendix E). This information sheet stated that participation was voluntary and that the participant had the right to withdraw at any time without penalty. It also indicated that the information disclosed would be held securely and treated confidentially. In addition, the participants were required to sign a consent form agreeing to be involved in the research. Consent was obtained without the use of duress. These procedures particularly addressed the ethical principles of autonomy, respect for persons and non-maleficence. The researcher delivered lectures to the students as part of the Nurse Prescriber programme and could therefore be considered to have some authority over them. In his discussion of practitioner research by schoolteachers, Doyle (2007) highlights the powerful position teachers are in and stresses that it is unethical to coerce students into participating. He notes that the relationship of power between teacher and students is not at a personal level, but historically and socially engrained in the role of the teacher. Doyle (2007) explains that it is not just children who are subject to this power but also adults when put into the role of students. Mockler (2007) discusses the complexity of research ethics in practitioner research. She considers the difficulty students may have in opting out of participation in research as students may consider they are identifiable by their absence and may fear reprisal. In researching one's own students there is a need for a heightened awareness of the ethical implications and a need to ensure clear information is given about the study to the students, allowing them to give informed consent, and trying to ensure this is voluntary and not influenced by the lecturer–student power relationship (Tarling, 2002). Every effort was made to ensure ethical practice in this study.

The storage of data (including tape recordings) has been and continues to be secure and complies with the Data Protection Act of 1998. Mockler (2007)

states the importance of only using data for the purpose for which it was collected, and to use it without first censoring it. This advice has been followed in the current study.

The naming of the University where the study took place would raise issues of anonymity and confidentiality of subjects. The number of participants is large enough to make identification of individual participants difficult, and the identification coding used means that responses are not identified with particular individuals. Steps have been taken to reduce the likelihood of identifying the University where the study occurred, however if it is identified, the programme is also identified and this does not provide absolute anonymity to the participants. True anonymity would mean that the researchers themselves would not be able to identify the responses with a particular participant (Bell, 2005), this level of anonymity has not been sought because it would have required that the researcher did not conduct interviews, Bell (2005) recognises that true anonymity is unlikely to be achieved in small qualitative studies. However, although the participant group is identified in this study, and the geographical area can be identified, the identity of the participants was hidden by use of identification codes for both questionnaires and for the interviews. Great care was taken to ensure confidentiality, that is, ensuring the participants were not identifiable in reporting findings (Bell, 2005). To avoid the possibility of identifying individuals interviewed, the identification codes used during transcription were removed before reporting results. At no time was the individual participant identifiable through the information appearing in this study.

Data collection and analysis

Data were generated from both questionnaires and from interviews using a sample of nurses undertaking the Nurse Prescriber programme. The researcher had access to the intended participants for this study at the University at which the researcher worked. A general invitation to participate was made to the students at the end of a teaching session. Participant information sheets were provided (see appendix E), these were read by the

students and the information was verbally explained to the students. Prospective participants were explicitly told that they did not have to participate and that they would not influence their progress on the course if they decided not to participate. Data gathering occurred on site at this place, a University campus. Questionnaires were completed within a classroom setting and interviews within a private office. Permission was received from the Head of Department, the Programme Leader and the University Ethics committee. Participants were again reminded that there was no obligation for them to take part in the research and that they could withdraw at any stage without penalty.

Sampling

Sampling was purposive, that is, the participants were selected based on the research topic (Cohen et al, 2000). This is in contrast to the random sampling typical of quantitative studies that seek to be representative of a large population, here the purpose is to identify clearly members of the 'case' that is being studied and select the participants because they fit the topic. In this case all students on the Nurse Prescriber programmes formed the population and participants were selected from these. Three separate intakes of students were approached to participate in the study, providing a total sample of 75. All these students were invited to participate, and questionnaires were administered. Students were asked to identify if they would be willing to be interviewed, with the interviews arranged later at a suitable time and place. As the data were collected and analysed, purposive sampling was used to deliberately choose participants for the interviews to find out more about a particular emerging category. For example, data were collected from a nurse who worked in a mental health setting to see whether issues identified by nurses in other settings were similar. The terms 'purposive sampling' and 'theoretical sampling' are often used interchangeably to identify this deliberate selection of participants with certain desired characteristics (Higginbottom, 2004). For example Punch (2005) identifies theoretical sampling as one type of purposive sampling and Sim and Wright (2000) link these two terms. The term 'theoretical sampling' is, however, generally associated with research using a grounded theory approach or where new theory is being generated.

Strauss and Corbin (1998) argue that theoretical sampling should remain flexible, enabling variation and the collection of richer data. These recommendations for theoretical sampling were also applied to purposive sampling in this study. That is, features of the whole cohort of Nurse Prescribers were considered from the questionnaire data and interviews were conducted with individuals across the features identified. Sim and Wright (2000, p119) call this 'judgemental sampling' – that is the researcher selects participants because of their characteristics with the aim of including representatives across the group studied.

Questionnaire

Data collection was initially by questionnaire. After obtaining consent for participation, the questionnaire was administered in class. The purpose of this was to elicit individual views, without students having the opportunity to discuss with others. The questions were mainly of a closed type, with occasional opportunity for further information to be included. The shortness of the questionnaire was intended to increase the number of returns. Data from the questionnaires were summarised using descriptive statistics to provide a picture of the participants as an overall group, such as the age profile and number of years nursing. Comments were summarised, with numerical values applied to indicate the number and percentage of participants giving each response.

All nurses entering as students onto the Nurse Prescriber programme were invited to complete the short questionnaire to include information about their academic and other qualifications, their age category, their length of experience as a nurse, their formal training in biosciences and a snapshot of their view of their own biological knowledge. This information was considered to be important to enable some manipulation of the data by these different groupings. Questionnaires are widely used in research (Saks and Allsop, 2007) and enable the collection of data in a structured manner in a fairly short period of time. They are used in case study research for the collection of 'simple, factual information' (Gillham, 2000, p59), particularly using closed questions. There was no existing questionnaire that lent itself directly to this study; therefore a new questionnaire was devised. There is an assumption

that the questions are understood in the way they were intended by the researcher, and that the information required by the questions is available to the respondent. Poorly constructed questionnaires may not distinguish between categories of response and may introduce bias (Cohen et al, 2000). For example, it is possible to ask a question that is misleading and is responded to in a way that was not intended, and questions may be constructed that lead the respondent to a preferred answer. The questions were first tested on a small group of 12 students to check for evidence of misunderstanding or bias, minor changes were made as a result of this test. For example, a change was made to the question on job role. The question had been about area of work; in the pilot this was interpreted differently by different respondents, so the question was changed to ask for area of specialism and job title. Given the diversity of the students completing the questionnaire, the questions were made as simple as possible. The questionnaire was then administered to 75 students in three separate cohorts of the Nurse prescriber programme over a period of 6 months. This generated a return of 42 fully completed questionnaires that were subjected to analysis (56% response rate). This is considered an adequate response rate (Sim and Wright, 2000). The questionnaire took approximately 15 minutes to complete, which the research literature suggests is a relatively short duration (Sim and Wright, 2000). While this is not a long time, it is possible for respondents to become disinterested and tick any box with a view to completing the questionnaire, the box ticked may not represent the true answer. This is a fault of all self-completed questionnaires, and does not apply to this one to any greater extent. The questionnaire was seven pages in length (see appendix A), with clear typeface, and participants commented that it was easy to complete. In fact, most students expressed a real interest in being involved in completing the questionnaire and asked to be notified of the results when they were available as they considered the topic to be very important.

Analysis of questionnaires occurred by entering the data in to the SPSS computer package and generating descriptive statistics. Comparison between groups was made using the cross tabs feature of the same package.

Interviews

Further data collection was by semi-structured, tape-recorded interview, which is a common technique used for case study (Charmaz, 2006). Students were invited to register their interest in being interviewed to elicit further information. 12 students on the Nurse Prescriber programme initially volunteered to be interviewed, no further request was made for participation in interviews. Students left contact details with the researcher and a suitable time and place were arranged for the interviews to occur in an uninterrupted manner. The interviews took place in the researcher's office or in the office of the interviewee. Gillham (2000) identifies semi-structured interviews as using both closed and open questions to explore a topic and 'the most important form of interviewing' in case study research (p65) because they can be relatively flexible. For example, the interviewer has the opportunity to explore some statements more fully than is possible with a structured questionnaire, enabling greater depth of response to be obtained where the respondent had a story to tell. Interviews are time-consuming but very useful in collecting data that has 'richness' (Gillham, 2000, p62). In using semi-structured interviews the interviewer asked similar questions of all participants (see appendix G). The interviews conducted were scheduled for an hour, with agreement that if further information was needed a second interview would be scheduled. Interview length varied between 40 and 60 minutes and no interview was extended to a second sitting. Interviews are useful to collect data from a relatively small number of people particularly if those people have been selected for their representation of a wider group (Miles and Huberman, 2002). Although the initial sample for interview self identified at invitation to the whole student group, there was the flexibility to approach other students to ensure a range of nursing roles were represented, this was used to ensure representation of community, acute general hospital and mental health nursing roles, and those who had been qualified for many years as well as those who had been qualified only a few years. At the initial invitation the researcher did not know which students would volunteer for interview. However, volunteers occurred across mental health nursing, community nursing and acute general hospital nursing, and across the range of years of

qualification. This positive response may be due to the level of interest in the study previously alluded to.

A friendly atmosphere was created to set the interviewee at ease. All interviews were preceded by a short explanation of the research topic, a confirmation that the tape and transcript would be held securely, and assurance that the interviewee would not be identifiable even though some of what they said my be inserted into the thesis verbatim, this is recommended by Carter and Henderson (2005). Confirmation was provided stating that the interviewee could stop the interview at any time, and withdraw from the research study at any time, without penalty. A glass of water was provided and the interviewee was offered a hot drink. The interview questions were mainly open, allowing the interviewee to tell their own story within the frame of the question. Closed questions were used for clarification of points raised by the interviewee. Carter and Henderson (2005) give specific guidance on how to conduct interviews to promote fairness and avoid bias or leading by the interviewer. The interviewer used a list of topic areas and open-ended questions were constructed from these topic areas. The interviewer avoided the use of leading questions and avoided making judgements about the material the interviewee was providing. The interviewer was conscious of the need to avoid making assumptions about the information provided, and probing was used to elicit further detail when required. The main strategy here was the use of 'tell me more' as a direction, or by the use of checking statements such as 'are you still referring to x, or are you thinking of another example?' Rather than expressing particular interest, or indicating that a situation was good or bad, the interviewer checked to see if the information received was what the participant intended. This was achieved through reflecting back regular short summaries of the participant's disclosures, and clarifying what had been said.

The semi-structured interviews first considered biographical data, concentrating on the interviewee's experience in nursing, finding out when they first trained as a nurse and their roles and work experience during their time in nursing. Their recent role was discussed in some detail. The nurse's

own confidence in their bioscience knowledge was then explored under the headings of anatomy, physiology, microbiology, pharmacology and biochemistry, with examples drawn out from the nurse's experience. The interviews continued with an exploration of the nurse's own area of practice and the breadth and the depth of the bioscience knowledge held in relation to this. The focus here was the current work role or very recent work roles. The extent to which the nurse identified formal or informal methods of teaching and learning as the source of their bioscience knowledge, whether before initial training, during or afterwards was explored at an appropriate point in the interview. For example, the use of lectures, textbooks or structured learning tasks in relation to an educational programme of study was explored, as were the informal methods by which the nurse had gained knowledge of the biosciences, including from friends, colleagues, reading, or clinical experience. This explored the aspects of learning that had not related directly to a component of an educational programme.

Interview schedules enabled the researcher to ask questions on the pre-determined set of topics, but were not so prescriptive as to exclude valuable insights from the participants. These interview questions had been generated based on the research questions and the literature review. There was a need to keep an open mind, to allow the participant to tell their story (Gillham, 2000) and not be restricted by specific questions, but the main research questions formed the basis of the interview. Some participants were much more forthcoming with their answers than others. The interviews were managed by prompting those who were more reluctant to talk and, for those interviewees who were keen to talk away from the main topic, repeating the question or rephrasing the question to bring the discussion back to the topic identified.

Gillham (2000) cautions against jumping to conclusions too early, and advises taking time to examine all the evidence. Initially all taped interviews were transcribed. This was a very time consuming process, but invaluable in moving to the coding stage. The researcher made notes of the interviewee's job area and expertise at the start of the interview so that a tally of the range of roles of interviewees was available. The interviewer also made brief notes

at the conclusion of the interview of any further points requiring exploration. There was only one interviewer, the researcher, across all interviews.

Data from interview transcripts were transcribed using A, B, C, etc as the codes to identify the different transcriptions. The transcriptions were read through and initially coded using descriptive coding, that is, data were summarised under simple descriptive headings, without 'interpretation' or 'inference' (Punch, 2005, p200). Notes written by the researcher were available in hard copy. For example, 'fear in an unknown clinical area' was an initial descriptive code taken firstly from the transcription '*I had been onto the ENT ward once before to cover someone's tea break and was absolutely petrified by the whole thing of patients with tracheostomies and that sort of thing and went into that role, that staff nurse job, with a bit of trepidation*'. If this idea of 'fear in an unknown clinical area' occurred again in the same or other transcripts, it was given the same code. At this stage, there was no attempt to explain the fear or give meaning to this. Descriptive coding is useful in starting the analysis (Punch, 2005). Transcriptions were read and re-read to ensure coding was thorough and made sense across the transcriptions. Descriptive codes were then listed and the number of occasions on which they occurred across the transcribed interviews was calculated.

This process of descriptive coding was followed by pattern codes. Designed to identify links between the initial descriptive codes, these pattern codes are 'interpretive' (Punch, 2005, p200). In this study, an example of a pattern code used is 'Formal education in bioscience is valuable after registration as a nurse' – this emerged from initial descriptive codes related to 'education and specialist role', 'post-registration courses' and 'bioscience in courses'. The reasons for coding, the property of the data and links to developing categories followed from this coding. The descriptive code of 'fear in an unknown clinical area' was an example of a code that was revisited during pattern coding. In trying to interpret the meaning behind the statement provided for this descriptive code, the tape was listened to again to ensure context had been taken into account and to look for any meaning applied to the statement.

It became clear that in fact the nurse felt unprepared to work in a particular clinical area. The descriptive code of 'fear in an unknown clinical area' became incorporated into the pattern code 'bioscience in pre-registration nursing programmes is inadequate'. Punch (2005) states that the purpose of the coding is to help conceptualization, to move away from the individual parts of the data and see the data with a greater level of abstraction. Particular attention to abstraction and comparison are suggested so that assumptions are not made. Gillham (2000) advises writing monthly reports about the findings and looking for data that does not fit codes, as well as that which does. Coding was carried out manually. Basit (2003) discusses the advantages and disadvantages of manual and electronic coding for qualitative data analysis and concludes that for relatively small amounts of data, manual techniques are as good as, if not better than, electronic means. Bassey's (1999, p65) advice was followed in ensuring enough data were generated to explore 'significant issues' of the case and ensure interpretations were 'plausible'. This was done through the five initial interviews and the subsequent deliberate selection of a further two interviewees. After the descriptive coding and the pattern coding stage, the researcher took time away from the codings and then returned to them several days later to check for the use of pre-conceptions and to ensure these were not included in final consideration of codings. Finally, conclusions were drawn, and references were made back to the data to confirm their trustworthiness. Gillham (2000, p22) advises the researcher to 'present the case report as a narrative' with evidence used throughout the narrative. This is the method of reporting findings that has been used for this thesis, both quantitative findings from the questionnaire and qualitative findings from the interviews are analysed together to provide a comprehensive analysis of the case.

It was originally anticipated that ten interviews would be carried out, however it became clear after five interviews that no further information was forthcoming. At this point only two more interviews were conducted and these interviews were used to focus on the emerging themes. The spread of interviewees across length of time qualified and job role was considered, and the next two interviews were deliberately conducted with a mental health nurse and a nurse who had only been qualified for a few years. These

participants had already volunteered to be interviewed. A total of seven interviews was conducted. This was realistic within the timeframe of the study and the number of students potentially available (75 students over six months).

In summary, this study uses a case study approach to elucidate aspects of bioscience knowledge of registered nurses undertaking a Nurse Prescriber programme. The case study approach was chosen to provide description of a group of nurses who have not yet been described and about whom there is limited knowledge, with the aim of producing a wide knowledge base. Data collection was by questionnaire to the majority of nurses on the programme, and interview with a small number of participants. In striving for trustworthiness in the research, an open approach has been taken, with considerable detail given about the participants and the processes of coding used. Additionally, as theory is built from the analysis of findings, clear arguments for theory are embedded in the data so that recommendations are based on evidence. The open approach taken enables transparent judgements to be made about the possibility of generalisation of findings. Ethical guidelines have been strictly adhered to, both in terms of the application to the Research Ethics committee for permission to carry out the study, and also in terms of following the spirit of the ethical guidelines in ensuring participants were very clear that they could exclude themselves from the study. All data have been held securely and the study complies with the Data Protection Act of 1998.

4. Findings and analysis

Bassey (1999), Bowling (2002) and Eisenhardt (2002) recommend, for case study research, that findings and analysis of those findings be presented together so that the data and the interpretation remain intimately associated. This advice has been followed in the current work. An initial summary of the quantitative and qualitative data is presented before detailed analysis of the findings. Findings from the questionnaires provide an overview of the participants. A summary of the findings by question is presented and the percentage and number of participants responding in each way is listed. Analysis of these overall results is included. The participants have also been grouped into categories, for example age, year of qualification, number of years nursing, job role. Results have been listed in relation to these groups to enable more detailed analysis to occur. Findings from the interviews provide greater depth with which to consider the results from the questionnaire. Lincoln and Guba (2002) and Punch (2005) recommend the inclusion of considerable detail regarding the process of coding used by the researcher, and listing of emerging themes and the rationale for these. The method of data analysis is explained in chapter 3 and the details of the coding are described in detail in the current chapter to enhance the trustworthiness of the work. Examples of interviewees' comments are given within the text and in separate figures (Figure 4.6). Analysis of the quantitative and qualitative results has been integrated to provide a synthesis embedded in all the data.

Quantitative findings

Completed questionnaires were analysed using the SPSS computer software package Version 13. Forty two registered nurses aged between 26 and 55 years completed questionnaires (the questionnaire is presented in Appendix 1). This included nurses who had qualified between 1972 and 2001 and represented twenty two from a hospital base, nine community nurses and eleven nurses attached to General Practice. Within these three groupings was a wide range of job roles (see appendix B). Thirty eight of those participating had passed GCSE or 'O' level biology or science before entering nurse training and 13 had passed 'A' level biology. Figure 4.1 summarises the participants. Although percentage values have been assigned, these

should be used with caution on a sample of this size, particularly where percentages have been applied to subcategories.

Figure 4.1 Summary of participants

Age group	Percentage of participants (numbers in brackets, n = 42)		Year of qualification	Percentage of participants (numbers in brackets, n = 42)		Years worked as RN	Percentage of participants (numbers in brackets, n = 42)
26 - 30	11.9 (5)		1972 – 1979	40.5 (17)		< 5	9.5 (4)
31 - 35	2.4 (1)		1980 – 1994	33.3 (14)		5 - 10	19.0 (8)
36 - 40	14.3 (6)		1995 +	26.2 (11)		11 - 15	9.5 (4)
41 - 45	19.0 (8)					16 - 20	9.5 (4)
46 - 50	33.3 (14)					21 - 25	26.2 (11)
51 - 55	19.0 (8)					26 - 30	21.4 (9)
56+	0 (0)					> 30	4.8 (2)

Data were subjected to the frequencies function of SPSS and descriptive statistics are presented in Figures 4.2 a – 4.2e. Because the emerging themes crossed much of the data collected by questionnaire, these figures are presented sequentially, and then referred to in the narrative. Each figure summarises results in relation to a topic identified on the questionnaire. Results were cross tabulated to identify any differences by age, by year qualified, by number of years nursing experience, and by job role. The keys to the groupings in this cross tabulation are shown below. Age groups were pre-determined on the questionnaire, using 5-year groupings; no respondents were under age 26 or over age 55. The questionnaire also required students to give the year of qualification as a registered nurse. This was then entered into groupings in SPSS. The groups were decided upon in relation to major curriculum changes in the pre-registration nursing curriculum. That is the introduction of the National Boards in 1979 and the introduction of Project 2000 and the move into Universities in the early 1990s (Salvage, 2003). Age group and year of qualification are not the same groupings, as age at entry into nursing has moved from average age 19 in the 1970s to average age in the late 20s today, with entrants to nursing now up to age 55 years (Ball and Pike, 2005).

Figure 4.2 Descriptive statistics for whole cohort

Codes used in identifying different groups of participants in the tabulated data.

Key		
Age groups	Year qualified	Number of years nursing
a = age 26 – 30 b = age 31 – 35 c = age 36 – 40 d = age 41 – 45 e = age 46 – 50 f = age 51 – 55	x = 1972 – 1979 y = 1980 – 1994 z = 1995 +	p = < 5 q = 5 - 10 r = 11 - 15 s = 16 - 20 t = 21 – 25 u = 26 – 30 v = > 30

Job role key:
A = Hospital based role (e.g. nurse specialist, staff nurse, sister) n = 22
B = Community based role (e.g district nurse, community matron) n = 9
C = GP practice based role (e.g practice nurse, nurse practitioner) n = 11

Figure 4.2a summarises the questionnaire findings relating to the extent of coverage of biosciences in the pre-registration nursing curriculum, the relationship between taught bioscience and practice and its adequacy in preparing for the role of registered nurse. Findings are given by age group, by year of qualification, and by number of years nursing experience. A detailed analysis of these findings is found under the emerging themes.

Figure 4.2a Pre-registration bioscience – content, link to practice and preparation for role as registered nurse.

This table summarises the findings from question 5 of the questionnaire.

Question	Percentage of responses in each category (number of responses in brackets, n = 42)		
	Content was extensive	*Content was adequate*	*Content was limited*
How extensive was the bioscience content of your pre-registration course? (Overall result)	**9.5 (4)**	**33.3 (14)**	**57.1 (24)**
How extensive was the bioscience content of your pre-registration course? (By age group)	a = 0 (0) b = 0 (0) c = 0 (0) d = 25.0 (2) e = 7.1 (1) f = 12.5 (1)	a = 40.0 (2) b = 0 (0) c = 16.7 (1) d = 50 (4) e = 42.9 (6) f = 12.5 (1)	a = 60 (3) b = 100 (1) c = 83.3 (5) d = 25.0 (2) e = 50.0 (7) f = 75.0 (6)
How extensive was the bioscience content of your pre-registration course? (By year qualified)	x = 11.8 (2) y = 15.4 (2) z = 0 (0)	x = 29.4 (5) y = 46.2 (6) z = 25.0 (3)	x = 58.8 (10) y = 38.5 (5) z = 75.0 (9)
How extensive was the bioscience content of your pre-registration course? (By number of years worked as a nurse)	p = 0 (0) q = 0 (0) r = 0 (0) s = 0 (0) t = 36.4 (4) u = 0 (0) v = 0 (0)	p = 25.0 (1) q = 25.0 (2) r = 0 (0) s = 75.0 (3) t = 27.3 (3) u = 44.4 (4) v = 50.0 (1)	p = 75.0 (3) q = 75.0 (6) r = 100.0 (4) s = 25.0 (1) t = 36.4 (4) u = 55.6 (5) v =50.0 (1)
	Usually	*Sometimes*	*Rarely*
Did the bioscience in your pre-registration course link to practice? (Overall result)	**40.5 (17)**	**45.2 (19)**	**14.3 (6)**
Did the bioscience in your pre-registration course link to practice? (By age group)	a = 20.0 (1) b = 0 (0) c = 50.0 (3) d = 62.5 (5) e = 50.0 (7) f = 12.5 (1)	a = 60.0 (3) b = 0 (0) c = 16.7 (1) d = 37.5 (3) e = 42.9 (6) f =75 (6)	a = 20.0 (1) b = 100.0 (1) c = 33.3 (3) d = 0 (0) e = 7.1 (1) f =12.5 (1)
Did the bioscience in your pre-registration course link to practice? (By year qualified)	x = 47.1 (8) y = 61.5 (8) z = 8.3 (1)	x = 47.1 (8) y = 30.8 (4) z =58.3 (7)	x = 5.9 (1) y = 7.7 (1) z = 33.3 (4)
Did the bioscience in your pre-registration course link to practice? (By number of years worked as a nurse)	p = 0 (0) q = 12.5 (1) r = 0 (0) s = 75.0 (3) t = 63.6 (7) u = 55.6 (5) v =50.0 (1)	p = 25.0 (1) q = 62.5 (5) r = 100.0 (4) s = 25.0 (1) t = 36.4 (4) u = 33.3 (3) v = 50.0 (1)	p = 75.0 (3) q = 25.0 (2) r = 0 (0) s = 0 (0) t = 0 (0) u = 11.1 (1) v = 0 (0)
	Prepared me well	*Prepared me adequately*	*Did not adequately prepare me*
Did the bioscience in your pre-registration course prepare you for your role as a registered nurse? (Overall result)	**19.0 (8)**	**40.5 (17)**	**40.5 (17)**
Did the bioscience in your pre-registration course prepare you for your role as a registered nurse? (By age group)	a = 20.0 (1) b = 0 (0) c = 0 (0) d = 37.5 (3) e = 21.4 (3) f = 12.5 (1)	a = 20.0 (1) b = 0 (0) c = 50.0 (3) d = 37.5 (3) e = 42.9 (6) f =50.0 (4)	a = 60.0 (3) b = 100.0 (1) c = 50.0 (3) d = 25.0 (2) e = 35.7 (5) f =37.5 (3)
Did the bioscience in your pre-registration course prepare you for your role as a registered nurse? (By year qualified)	x = 11.8 (2) y = 30.8 (4) z = 16.7 (2)	x = 52.9 (9) y = 46.2 (6) z = 16.7 (2)	x = 35.3 6) y = 23.1 (3) z = 66.7 (8)
Did the bioscience in your pre-registration course prepare you for your role as a registered nurse? (By number of years worked as a nurse)	p = 25.0 (1) q = 12.5 (1) r = 0 (0) s = 25.0 (1) t = 36.4 (4) u = 0 (0) v = 50.0 (1)	p = 25.0 (1) q = 25.0 (2) r = 25.0 (1) s = 25.0 (1) t = 36.4 (4) u = 77.8 (7) v = 50.0 (1)	p = 50.0 (2) q = 62.5 (5) r = 75.0 (3) s = 50.0 (2) t = 27.3 (3) u = 22.2 (2) v = 0 (0)

Figure 4.2b first summarises the findings for the extent of coverage of five separate bioscience areas in the pre-registration nursing curriculum. Findings are presented by age group, by year of qualification, and by number of years working as a nurse. The later section of the table summarises the relevance of the five separate bioscience areas to the pre-registration nursing curriculum. As well as considering these by age, year of qualification and years of nursing experience, these results are also given by job role groups.

Figure 4.2b Coverage and relevance of the different components of bioscience

This table summarises the findings from question 6 of the questionnaire

Topic	**Percentage of responses in each category (number of responses in brackets, n = 42)**			
	Very limited	*Limited*	*Adequate*	*Extensive*
Coverage of anatomy in your pre-registration programme (Overall result)	**2.4 (1)**	**35.7 (15)**	**54.8 (23)**	**7.1 (3)**
Coverage of anatomy in your pre-registration programme (By age group)	a = 0 (0) b = 0 (0) c = 16.7 (1) d = 0 (0) e =0 (0) f =0 (0)	a = 40.0 (2) b = 100.0 (1) c = 33.3 (2) d = 25.0 (2) e = 28.6 (4) f = 50.0 (4)	a = 60.0 (3) b = 0 (0) c = 50.0 (3) d = 62.5 (5) e = 64.3 (9) f = 37.5 (3)	a = 0 (0) b = 0 (0) c = 0 (0) d = 12.5 (1) e = 7.1 (1) f = 12.5 (1)
Coverage of anatomy in your pre-registration programme (By year qualified)	x = 0 (0) y = 0 (0) z = 8.3 (1)	x = 29.4 (5) y = 23.1 (3) z = 58.3 (7)	x = 58.8 (10) y = 69.2 (9) z = 33.3 (4)	x = 11.8 (2) y = 7.7 (1) z = 0 (0)
Coverage of anatomy in your pre-registration programme (By number of years worked as a nurse)	p = 0 (0) q = 12.5 (1) r = 0 (0) s = 0 (0) t = 0 (0) u = 0 (0) v =0 (0)	p = 25.0 (1) q = 62.5 (5) r = 75.0 (3) s = 0 (0) t = 27.3 (3) u = 33.3 (3) v =0 (0)	p = 75.0 (3) q = 25.0 (2) r = 25.0 (1) s = 100.0 (4) t = 63.6 (7) u = 55.6 (5) v =50.0 (1)	p = 0 (0) q = 0 (0) r = 0 (0) s = 0 (0) t = 9.1 (1) u = 11.1 (1) v = 50.0 (1)
Coverage of physiology in your pre-registration programme (Overall result)	**2.4 (1)**	**42.9 (18)**	**47.6 (20)**	**7.1 (3)**
Coverage of physiology in your pre-registration programme (By age group)	a = 0 (0) b = 0 (0) c = 16.7 (1) d = 0 (0) e = 0 (0) f = 0 (0)	a = 60.0 (3) b = 100.0 (1) c = 16.7 (1) d = 50.0 (4) e = 35.7 (5) f = 50.0 (4)	a = 40.0 (2) b = 0 (0) c = 66.7 (4) d = 37.5 (3) e = 57.1 (8) f = 37.5 (3)	a = 0 (0) b = 0 (0) c = 0 (0) d = 12.5 (1) e = 7.1 (1) f =12.5 (1)
Coverage of physiology in your pre-registration programme (By year qualified)	x = 0 (0) y = 0 (0) z = 8.3 (1)	x = 29.4 (5) y = 38.5 (5) z = 66.7 (8)	x = 58.8 (10) y = 53.8 (7) z = 25.0 (3)	x = 11.8 (2) y = 7.7 (1) z =0 (0)
Coverage of physiology in your pre-registration programme (By number of years worked as a nurse)	p = 0 (0) q = 12.5 (1) r = 0 (0) s = 0 (0) t = 0 (0) u = 0 (0) v = 0 (0)	p = 25.0 (1) q = 75.0 (6) r = 75.0 (3) s = 25.0 (1) t = 27.3 (3) u = 44.4 (4) v =0 (0)	p = 75.0 (3) q = 12.5 (1) r = 25.0 (1) s = 75.0 (3) t = 63.6 (7) u = 44.4 (4) v =50.0 (1)	p = 0 (0) q = 0 (0) r = 0 (0) s = 0 (0) t = 9.1 (1) u = 11.1 (1) v = 50.0 (1)
Coverage of microbiology in your pre-registration programme (Overall result)	**35.7 (15)**	**52.4 (22)**	**7.1 (3)**	**4.8 (2)**
Coverage of microbiology in your pre-registration programme (By age group)	a = 60.0 (3) b = 100.0 (1) c = 50.0 (3) d = 25.0 (2) e = 21.4 (3) f =37.5 (3)	a = 40.0 (2) b = 0 (0) c = 50.0 (3) d = 75.0 (6) e = 64.3 (9) f =25.0 (2)	a = 0 (0) b = 0 (0) c = 0 (0) d = 0 (0) e = 14.3 (2) f =12.5 (1)	a = 0 (0) b = 0 (0) c = 0 (0) d = 0 (0) e = 0 (0) f =25.0 (2)
Coverage of microbiology in your pre-registration programme (By year qualified)	x = 5.9 (1) y = 30.8 (4) z =83.3 (10)	x = 70.6 (12) y = 61.5 (8) z = 16.7 (2)	x = 11.8 (2) y = 7.7 (1) z =0 (0)	x = 11.8 (2) y = 0 (0) z = 0 (0)
Coverage of microbiology in your pre-registration programme (By number of years worked as a nurse)	p = 50.0 (2) q = 100.0 (8) r = 75.0 (3) s = 0 (0) t = 9.1 (1) u = 11.1 (1) v = 0 (0)	p = 50.0 (2) q = 0 (0) r = 0 (0) s = 100.0 (4) t = 72.7 (8) u = 77.8 (7) v =50.0 (1)	p = 0 (0) q = 0 (0) r = 25.0 (1) s = 0 (0) t = 9.1 (1) u = 0 (0) v = 50.0 (1)	p = 0 (0) q = 0 (0) r = 0 (0) s = 0 (0) t = 9.1 (1) u = 11.1 (1) v = 0 (0)

4.2b Coverage and relevance of the different components of bioscience - continued

Topic	**Percentage of responses in each category (number of responses in brackets, n = 42)**			
	Very limited	*Limited*	*Adequate*	*Extensive*
Coverage of pharmacology in your pre-registration programme (Overall result)	**57.1 (24)**	**26.2 (11)**	**14.3 (6)**	**2.4 (1)**
Coverage of pharmacology in your pre-registration programme (By age group)	a = 60.0 (3) b = 100.0 (1) c = 50.0 (3) d = 62.5 (5) e = 42.9 (6) f =75.0 (6)	a = 0 (0) b = 0 (0) c = 33.3 (2) d = 25.0 (2) e = 35.7 (5) f =25.0 (2)	a = 40.0 (2) b = 0 (0) c = 16.7 (1) d = 12.5 (1) e = 14.3 (2) f =0 (0)	a = 0 (0) b = 0 (0) c = 0 (0) d = 0 (0) e = 7.1 (1) f = 0 (0)
Coverage of pharmacology in your pre-registration programme (By year qualified)	x = 47.1 (8) y = 53.8 (7) z =75.0 (9)	x = 35.3 (6) y = 30.8 (4) z = 8.3 (1)	x = 11.8 (2) y = 15.4 (2) z = 16.7 (2)	x = 5.9 (1) y = 0 (0) z =0 (0)
Coverage of pharmacology in your pre-registration programme (By number of years worked as a nurse)	p = 75.0 (3) q = 75.0 (6) r = 75.0 (3) s =25.0 (1) t = 54.5 (6) u = 55.6 (5) v = 0 (0)	p = 0 (0) q = 12.5 (1) r = 25.0 (1) s = 75.0 (3) t = 18.2 (2) u = 33.3 (3) v =50.0 (1)	p = 25.0 (1) q = 12.5 (1) r = 0 (0) s = 0 (0) t = 27.3 (3) u = 11.1 (1) v =0 (0)	p = 0 (0) q = 0 (0) r = 0 (0) s = 0 (0) t = 0 (0) u = 0 (0) v =50.0 (1)
Coverage of biochemistry in your pre-registration programme (Overall result)	**57.1 (24)**	**33.3 (14)**	**9.5 (4)**	**0 (0)**
Coverage of biochemistry in your pre-registration programme (By age group)	a = 40.0 (2) b = 100.0 (1) c = 50.0 (3) d = 62.5 (5) e = 57.1 (8) f =62.5 (5)	a = 60.0 (3) b = 0 (0) c = 33.3 (2) d = 37.5 (3) e = 28.6 (4) f =25.0 (2)	a = 0 (0) b = 0 (0) c = 16.7 (1) d = 0 (0) e = 14.3 (2) f = 12.5 (1)	a = 0 (0) b = 0 (0) c = 0 (0) d = 0 (0) e = 0 (0) f = 0 (0)
Coverage of biochemistry in your pre-registration programme (By year qualified)	x = 52.9 (9) y = 53.8 (7) z = 66.7 (8)	x = 29.4 (5) y = 38.5 (5) z =33.3 (4)	x = 17.6 (3) y = 7.7 (1) z =0 (0)	x = 0 (0) y = 0 (0) z = 0 (0)
Coverage of biochemistry in your pre-registration programme (By number of years worked as a nurse)	p = 75.0 (3) q = 62.5 (5) r = 100.0 (4) s = 25.0 (1) t = 45.5 (5) u = 55.6 (5) v =50.0 (1)	p = 25.0 (1) q = 37.5 (3) r = 0 (0) s = 75.0 (3) t = 36.4 (4) u = 33.3 (3) v = 0 (0)	p = 0 (0) q = 0 (0) r = 0 (0) s = 0 (0) t = 18.2 (2) u = 11.1 (1) v = 50.0 (1)	p = 0 (0) q = 0 (0) r = 0 (0) s = 0 (0) t = 0 (0) u = 0 (0) v = 0 (0)

4.2b Coverage and relevance of the different components of bioscience - continued

Job role key:
A = Hospital based role (e.g. nurse specialist, staff nurse, sister) n = 22
B = Community based role (e.g district nurse, community matron) n = 9
C = GP practice based role (e.g practice nurse, nurse practitioner) n = 11

Topic	**Percentage of responses in each category (number of responses in brackets, n = 42)**			
	Not relevant	*Partly relevant*	*Fairly relevant*	*Highly relevant*
Relevance of anatomy to the pre-registration programme (Overall result)	**2.4 (1)**	**21.4 (9)**	**33.3 (14)**	**42.9 (18)**
Relevance of anatomy to the pre-registration programme (By age group)	a = 0 (0) b = 0 (0) c = 16.7 (1) d = 0 (0) e = 0 (0) f = 0 (0)	a = 0 (0) b = 100.0 (1) c = 33.3 (2) d = 12.5 (1) e = 14.3 (2) f =37.5 (3)	a = 40.0 (2) b = 0 (0) c = 33.3 (2) d = 25.0 (2) e = 42.9 (6) f =25.0 (2)	a = 60.0 (3) b = 0 (0) c = 16.7 (1) d = 62.5 (5) e = 42.9 (6) f =37.5 (3)
Relevance of anatomy to the pre-registration programme (By year qualified)	x = 0 (0) y = 0 (0) z = 8.3 (1)	x = 23.5 (4) y = 7.7 (1) z = 33.3 (4)	x = 47.1 (8) y = 30.8 (4) z = 16.7 (2)	x = 29.4 (5) y = 61.5 (8) z = 41.7 (5)
Relevance of anatomy to the pre-registration programme (By number of years worked as a nurse)	p = 0 (0) q = 12.5 (1) r = 0 (0) s = 0 (0) t = 0 (0) u = 0 (0) v =0 (0)	p = 25.0 (1) q = 37.5 (3) r =25.0 (1) s = 0 (0) t = 9.1 (1) u = 33.3 (3) v = 0 (0)	p = 50.0 (2) q = 12.5 (1) r = 0 (0) s = 50.0 (2) t = 45.5 (5) u = 44.4 (4) v = 0 (0)	p = 25.0 (1) q = 37.5 (3) r = 75.0 (3) s = 50.0 (2) t = 45.5 (5) u = 22.2 (2) v =100.0 (2)
Relevance of anatomy to the pre-registration programme (By job role)	A = 0 (0) B = 11.1 (1) C = 0 (0)	A = 27.3 (6) B = 33.3 (3) C = 0 (0)	A = 22.7 (5) B = 33.3 (3) C = 54.5 (6)	A = 50.0 (11) B = 22.2 (2) C = 45.5 (5)
Relevance of physiology to the pre-registration programme (Overall result)	**2.4 (1)**	**19.0 (8)**	**31.0 (13)**	**47.6 (20)**
Relevance of physiology to the pre-registration programme (By age group)	a = 0 (0) b = 0 (0) c = 16.7 (1) d = 0 (0) e = 0 (0) f =0 (0)	a = 20.0 (1) b = 100.0 (1) c = 16.7 (1) d = 12.5 (1) e = 14.3 (2) f =25.0 (2)	a = 20.0 (1) b = 0 (0) c = 33.3 (2) d = 25.0 (2) e = 42.9 (6) f = 25.0 (2)	a = 60.0 (3) b = 0 (0) c = 33.3 (2) d = 62.5 (5) e = 42.9 (6) f = 50.0 (4)
Relevance of physiology to the pre-registration programme (By year qualified)	x = 0 (0) y = 0 (0) z =8.3 (1)	x = 11.8 (2) y = 7.7 (1) z = 41.7 (5)	x = 47.1 (8) y = 30.8 (4) z =8.3 (1)	x = 41.2 (7) y = 61.5 (8) z =41.7 (5)
Relevance of physiology to the pre-registration programme (By number of years worked as a nurse)	p = 0 (0) q = 12.5 (1) r = 0 (0) s = 0 (0) t = 0 (0) u = 0 (0) v = 0 (0)	p = 25.0 (1) q = 50.0 (4) r = 0 (0) s = 0 (0) t = 0 (0) u = 33.3 (3) v = 0 (0)	p = 50.0 (2) q = 0 (0) r = 0 (0) s = 50.0 (2) t = 45.5 (5) u = 44.4 (4) v = 0 (0)	p = 25.0 (1) q = 37.5 (3) r = 100.0 (4) s = 50.0 (2) t = 54.5 (6) u = 22.2 (2) v = 100.0 (2)
Relevance of physiology to the pre-registration programme (By job role)	A = 0 (0) B = 11.1 (1) C = 0 (0)	A = 18.2 (4) B = 44.4 (4) C = 0 (0)	A = 22.7 (5) B = 22.2 (2) C = 54.5 (6)	A = 59.1 (13) B = 22.2 (2) C = 45.5 (5)

4.2b Coverage and relevance of the different components of bioscience - continued

Topic	Percentage of responses in each category (number of responses in brackets, n = 42)			
	Not relevant	*Partly relevant*	*Fairly relevant*	*Highly relevant*
Relevance of microbiology to the pre-registration programme (Overall result)	**11.9 (5)**	**21.4 (9)**	**47.6 (20)**	**19.0 (8)**
Relevance of microbiology to the pre-registration programme (By age group)	a = 0 (0) b = 0 (0) c = 50.0 (3) d = 0 (0) e = 7.1 (1) f =12.5 (1)	a = 20.0 (1) b = 100.0 (1) c = 0 (0) d = 12.5 (1) e = 35.7 (5) f =12.5 (1)	a = 60.0 (3) b = 0 (0) c = 50.0 (3) d = 37.5 (3) e = 42.9 (6) f =62.5 (5)	a = 20.0 (1) b = 0 (0) c = 0 (0) d = 50.0 (4) e = 14.3 (2) f =12.5 (1)
Relevance of microbiology to the pre-registration programme (By year qualified)	x = 5.9 (1) y = 7.7 (1) z =25.0 (3)	x = 29.4 (5) y = 7.7 (1) z =25.0 (3)	x = 52.9 (9) y = 46.2 (6) z =41.7 (5)	x = 11.8 (2) y = 38.5 (5) z =8.3 (1)
Relevance of microbiology to the pre-registration programme (By number of years worked as a nurse)	p = 25.0 (1) q = 37.5 (3) r = 0 (0) s = 0 (0) t = 0 (0) u = 11.1 (1) v = 0 (0)	p = 25.0 (1) q = 25.0 (2) r = 0 (0) s = 0 (0) t = 9.1 (1) u = 55.6 (5) v = 0 (0)	p = 50.0 (2) q = 25.0 (2) r = 75.0 (3) s = 50.0 (2) t = 63.6 (7) u = 33.3 (3) v =50.0 (1)	p = 0 (0) q = 12.5 (1) r = 25.0 (1) s = 50.0 (2) t = 27.3 (3) u = 0 (0) v =50.0 (1)
Relevance of microbiology to the pre-registration programme (By job role)	A = 13.6 (3) B = 11.1 (1) C = 9.1 (1)	A = 9.1 (2) B = 55.6 (5) C = 18.2 (2)	A = 54.5 (12) B = 22.2 (2) C = 54.5 (6)	A = 22.7 (5) B = 11.1 (1) C = 18.2 (2)
Relevance of pharmacology to the pre-registration programme (Overall result)	**11.9 (5)**	**23.8 (10)**	**33.3 (14)**	**31.0 (13)**
Relevance of pharmacology to the pre-registration programme (By age group)	a = 0 (0) b = 0 (0) c = 50.0 (3) d = 0 (0) e = 7.1 (1) f =12.5 (1)	a = 0 (0) b = 100 (0) c = 16.7 (1) d = 12.5 (1) e = 28.6 (4) f =37.5 (3)	a = 60.0 (3) b = 0 (0) c = 16.7 (1) d = 25.0 (2) e = 35.7 (5) f =37.5 (3)	a = 40.0 (2) b = 0 (0) c = 16.7 (1) d = 62.5 (5) e = 28.6 (4) f =12.5 (1)
Relevance of pharmacology to the pre-registration programme (By year qualified)	x = 0 (0) y = 7.7 (1) z = 33.3 (4)	x = 35.3 (6) y = 23.1 (3) z = 8.3 (1)	x = 41.2 (7) y = 23.1 (3) z = 33.3 (4)	x = 11.8 (2) y = 38.5 (5) z = 8.3 (1)
Relevance of pharmacology to the pre-registration programme (By number of years worked as a nurse)	p = 25.0 (1) q = 50.0 (4) r = 0 (0) s =0 (0) t = 0 (0) u = 0 (0) v = 0(0)	p = 25.0 (1) q = 0 (0) r = 25.0 (1) s =25.0 (1) t = 18.2 (2) u = 55.6 (5) v = 0 (0)	p = 50.0 (2) q = 12.5 (1) r = 25.0 (1) s = 25.0 (1) t = 45.5 (5) u = 33.3 (3) v = 50.0 (1)	p = 0 (0) q = 37.5 (3) r = 50.0 (2) s = 50.0 (2) t = 36.4 (4) u = 11.1 (1) v = 50.0 (1)
Relevance of pharmacology to the pre-registration programme (By job role)	A = 13.6 (3) B = 22.2 (2) C = 0 (0)	A = 13.6 (3) B = 11.1 (1) C = 54.5 (6)	A = 36.4 (8) B = 44.4 (4) C = 18.2 (2)	A = 36.4 (8) B = 22.2 (2) C = 27.3 (3)
Relevance of biochemistry to the pre-registration programme (Overall result)	**11.9 (5)**	**26.2 (11)**	**40.5 (17)**	**21.4 (9)**
Relevance of biochemistry to the pre-registration programme (By age group)	a = 0 (0) b = 0 (0) c = 50.0 (3) d = 0 (0) e = 7.1 (1) f =12.5 (1)	a = 0 (0) b = 100.0 (1) c = 16.7 (1) d = 12.5 (1) e = 28.6 (4) f =50.0 (4)	a = 80.0 (4) b = 0 (0) c = 16.7 (1) d = 25.0 (2) e = 50.0 (7) f = 37.5 (3)	a = 20.0 (1) b = 0 (0) c = 16.7 (1) d = 62.5 (5) e = 14.3 (2) f =0 (0)
Relevance of biochemistry to the pre-registration programme (By year qualified)	x = 0 (0) y = 7.7 (1) z = 33.3 (4)	x = 41.2 (7) y = 23.1 (3) z = 8.3 (1)	x = 47.1 (8) y = 23.1 (3) z = 50.0 (6)	x = 11.8 (2) y = 46.2 (6) z = 8.3 (1)
Relevance of biochemistry to the pre-registration programme (By number of years worked as a nurse)	p = 25.0 (1) q = 50.0 (4) r = 0 (0) s = 0 (0) t = 0 (0) u = 0 (0) v = 0 (0)	p = 25.0 (1) q = 0 (0) r = 25.0 (1) s = 25.0 (1) t = 9.1 (1) u = 77.8 (7) v =0 (0)	p = 50.0 (2) q = 37.5 (3) r = 50.0 (2) s = 25.0 (1) t = 54.5 (6) u = 22.2 (2) v =50.0 (1)	p = 0 (0) q = 12.5 (1) r = 25.0 (1) s = 50.0 (2) t = 36.4 (4) u = 0 (0) v = 50.0 (1)
Relevance of biochemistry to the pre-registration programme (By job role)	A = 13.6 (3) B = 22.2 (2) C = 0 (0)	A = 13.6 (3) B = 33.3 (3) C = 45.5 (5)	A = 45.5 (10) B = 33.3 (3) C = 36.4 (4)	A = 27.3 (6) B = 11.1 (1) C = 18.2 (2)

Figure 4.2c summarises the findings for the level of confidence expressed by participants at the start of the Nurse Prescriber programme. Results are presented as a summary and by job role.

Figure 4.2c Confidence in bioscience knowledge at start of the Nurse Prescriber programme

This table summarises the findings from question 7 of the questionnaire.

Job role key:
A = Hospital based role (e.g. nurse specialist, staff nurse, sister) n = 22
B = Community based role (e.g district nurse, community matron) n = 9
C = GP practice based role (e.g practice nurse, nurse practitioner) n = 11

How confident were you in your knowledge at the start of the Nurse Prescriber programme?	**Percentage of responses in each category (number of responses in brackets, n = 42)**		
	Very little confidence	*Some confidence*	*Confidence*
Confidence in knowledge of Anatomy (overall)	**7.1 (3)**	**66.7 (28)**	**26.2 (11)**
Confidence in knowledge of anatomy by job role	A = 9.1 (2) B = 11.1 (1) C = 0 (0)	A = 54.5 (12) B = 77.8 (7) C = 81.8 (9)	A = 36.4 (8) B = 11.1 (1) C = 18.2 (2)
Confidence in knowledge of Physiology (overall)	**14.3 (6)**	**73.8 (31)**	**11.9 (5)**
Confidence in knowledge of physiology by job role	A = 18.2 (4) B = 22.2 (2) C =0 (0)	A = 68.2 (15) B = 77.8 (7) C =81.8 (9)	A = 13.6 (3) B = 0 (0) C =18.2 (2)
Confidence in knowledge of Microbiology (overall)	**38.1 (16)**	**52.4 (22)**	**9.5 (4)**
Confidence in knowledge of microbiology by job role	A = 40.9 (9) B = 33.3 (3) C =36.4 (4)	A = 50.0 (11) B = 55.6 (5) C =54.5 (6)	A = 9.1 (2) B = 11.1 (1) C =9.1 (1)
Confidence in knowledge of Pharmacology (overall)	**38.1 (16)**	**52.4 (22)**	**9.5 (4)**
Confidence in knowledge of pharmacology by job role	A = 45.5 (10) B = 22.2 (2) C = 36.4 (4)	A = 45.5 (10) B = 66.7 (6) C = 54.5 (6)	A = 9.1 (2) B = 11.1 (1) C =9.1 (1)
Confidence in knowledge of Biochemistry (overall)	**40.5 (17)**	**54.8 (23)**	**4.8 (2)**
Confidence in knowledge of biochemistry by job role	A = 36.4 (8) B = 55.6 (5) C =36.4 (4)	A = 59.1 (13) B = 44.4 (4) C =54.5 (6)	A = 4.5 (1) B = 0 (0) C =9.1 (1)

Figure 4.2d presents the findings as a summary and by job role for the level of bioscience knowledge the participants considered they needed for their current role, and the confidence with which this knowledge was held.

Figure 4.2d Knowledge needed and level of confidence in relation to current role

This table summarises the findings from questions 10 and 11 of the questionnaire.

Topic	**Percentage of responses in each category (number of responses in brackets, n = 42)**		
	Very little knowledge	*Some knowledge*	*A lot of knowledge*
Anatomy knowledge needed in relation to current role (overall)	**2.4 (1)**	**26.2 (11)**	**71.4 (30)**
Anatomy knowledge needed in relation to current role (by job role)	A = 4.5 (1) B = 0 (0) C = 0 (0)	A = 18.2 (4) B = 55.6 (5) C = 18.2 (2)	A = 77.3 (17) B = 44.4 (4) C = 81.8 (9)
Physiology knowledge needed in relation to current role (overall)	**2.4 (1)**	**31.0 (13)**	**66.7 (28)**
Physiology knowledge needed in relation to current role (by job role)	A = 4.5 (1) B = 0 (0) C = 0 (0)	A = 27.3 (6) B = 55.6 (5) C = 18.2 (2)	A = 68.2 (15) B = 44.4 (4) C = 81.8 (9)
Microbiology knowledge needed in relation to current role (overall)	**4.8 (2)**	**54.8 (23)**	**40.5 (17)**
Microbiology knowledge needed in relation to current role (by job role)	A = 9.1 (2) B = 0 (0) C = 0 (0)	A = 54.5 (12) B = 66.7 (6) C = 45.5 (5)	A = 36.4 (8) B = 33.3 (3) C = 54.5 (6)
Pharmacology knowledge needed in relation to current role (overall)	**2.4 (1)**	**23.8 (10)**	**73.8 (31)**
Pharmacology knowledge needed in relation to current role (by job role)	A = 4.5 (1) B = 0 (0) C = 0 (0)	A = 27.3 (6) B = 22.2 (2) C = 18.2 (2)	A = 68.2 (15) B = 77.8 (7) C = 81.8 (9)
Biochemistry knowledge needed in relation to current role (overall)	**4.8 (2)**	**52.4 (22)**	**42.9 (18)**
Biochemistry knowledge needed in relation to current role (by job role)	A = 4.5 (1) B = 11.1 (1) C = 0 (0)	A = 54.5 (12) B = 66.7 (6) C = 36.4 (4)	A = 40.9 (9) B = 22.2 (2) C = 63.6 (7)

	Don't need this subject	*Very little confidence*	*Some confidence*	*Confident*
Level of confidence of anatomy knowledge in relation to current role (overall)	**0 (0)**	**4.8 (2)**	**54.8 (23)**	**40.5 (17)**
Level of confidence of anatomy knowledge in relation to current role (by job role)	A = 0 (0) B = 0 (0) C = 0 (0)	A =0 (0) B = 22.2 (2) C = 0 (0)	A = 45.5 (10) B = 44.4 (4) C = 81.8 (9)	A = 54.5 (12) B = 33.3 (3) C = 18.2 (2)
Level of confidence of physiology knowledge in relation to current role (overall)	**0 (0)**	**4.8 (2)**	**61.9 (26)**	**33.3 (14)**
Level of confidence of physiology knowledge in relation to current role (by job role)	A = 0 (0) B = 0 (0) C = 0 (0)	A = 0 (0) B = 22.2 (2) C = 0 (0)	A = 59.1 (13) B = 55.6 (5) C = 72.7 (8)	A = 40.9 (9) B = 22.2 (2) C = 27.3 (3)
Level of confidence of microbiology knowledge in relation to current role (overall)	**2.4 (1)**	**31.0 (13)**	**57.1 (24)**	**9.5 (4)**
Level of confidence of microbiology knowledge in relation to current role (by job role)	A = 4.5 (1) B = 0 (0) C = 0 (0)	A = 31.8 (7) B = 33.3 (3) C = 27.3 (3)	A = 54.5 (12) B = 55.6 (5) C = 63.6 (7)	A = 9.1 (2) B = 11.1 (1) C = 9.1 (1)
Level of confidence of pharmacology knowledge in relation to current role (overall)	**0 (0)**	**11.9 (5)**	**71.4 (30)**	**16.7 (7)**
Level of confidence of pharmacology knowledge in relation to current role (by job role)	A = 0 (0) B = 0 (0) C = 0 (0)	A = 13.6 (3) B = 11.1 (1) C = 9.1 (1)	A = 63.6 (14) B = 77.8 (7) C = 81.8 (9)	A = 22.7 (5) B = 11.1 (1) C = 9.1 (1)
Level of confidence of biochemistry knowledge in relation to current role (overall)	**2.4 (1)**	**31.0 (13)**	**61.9 (26)**	**4.8 (2)**
Level of confidence of biochemistry knowledge in relation to current role (by job role)	A = 4.5 (1) B = 0 (0) C = 0 (0)	A = 27.3 (6) B = 55.6 (5) C = 18.2 (2)	A = 63.6 (14) B = 44.4 (4) C = 72.7 (8)	A = 4.5 (1) B = 0 (0) C = 9.1 (1)

The findings for factors that were considered to have helped learning of bioscience knowledge are summarised below in Figure 4.2e.

Figure 4.2e Factors that helped learning of bioscience

This table summarises the findings from question 12 of the questionnaire.

Question	**Percentage of responses in each category (number of responses in brackets, n = 42)**				
	Did not help	*Helped a little*	*Helped*	*Helped quite a lot*	*Helped a great deal*
Did teaching on your pre-registration programme help you to learn bioscience?	9.5 (4)	14.3 (6)	28.6 (12)	35.7 (15)	11.9 (5)
Did teaching on post-registration courses help you to learn bioscience?	4.8 (2)	2.4 (1)	19.0 (8)	57.1 (24)	16.7 (7)
Have books, the internet or other written sources helped you to learn bioscience?	9.5 (4)	0 (0)	19.0 (8)	45.2 (19)	26.2 (11)
Has discussion with colleagues helped you to learn bioscience?	4.8 (2)	0 (0)	23.8 (10)	40.5 (17)	31.0 (13)
Have experiences at work helped you to learn bioscience?	2.4 (1)	0 (0)	4.8 (2)	31.0 (13)	61.9 (26)

Qualitative findings

The first step in analysis of the interviews was to consider the first five interview transcriptions by careful reading and re-reading. Initial themes emerging from the transcriptions were identified and coded. The transcriptions were then read again to consider whether the themes and coding were transparent. A list of emerging themes was then made. This initial analysis for emerging themes produced 25 separate descriptive codes (see Figure 4.4a). Although some of the titles appear similar here, for example nursing terminology and medical/scientific terminology, separate descriptive codes were used if the context suggested there could be separate categories. The transcripts were then read again with the purpose of considering the descriptive codes applied and looking for pattern codes. The frequency of occurrence of each emerging theme by each interviewee was calculated (see Figure 4.4a).

Figure 4.3 Flow diagram demonstrating the process of data analysis

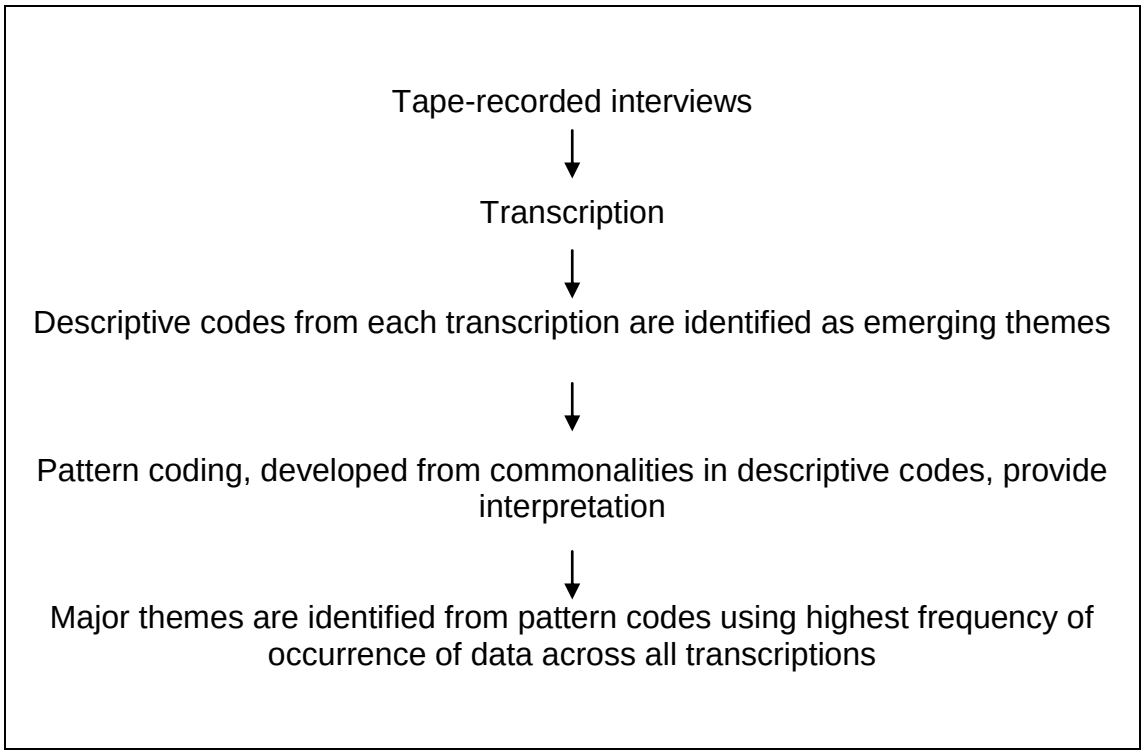


Figure 4.4a. List of emerging themes

Code	Descriptive coding	Frequency of occurrence in transcripts for each interviewee					
		A	B	C	D	E	Total
1	Nursing is secondary to other professions	1	2	-	-	-	3
2	Fear in an unknown clinical area	1	4	-	-	1	6
3	Education helping the specialist role	7	2	-	8	4	21
4	Human biology and nursing links	4	4	-	6	-	14
5	Quantity of bioscience in the curriculum in pre-registration programmes	1	2	2	1	2	8
6	Pre-registration bioscience insufficient for requirements	4	7	-	5	1	17
7	Concentration most on anatomy in the pre-registration programme rather than other aspects of bioscience	2	4	-	1	1	8
8	Limitations of pre-registration as preparation for role	1	9	1	7	1	19
9	Learning from colleagues about bioscience	3	5	5	4	1	18
10	Value of post-registration courses	2	1	5	3	3	14
11	Importance of theory to practice links and practice to theory links	5	9	7	4	2	27
12	Knowledge from texts	2	2	1	1	1	7
13	Medical/scientific terminology	1	-	1	1	1	4
14	Reduction of bioscience in pre-registration programme over the years	1	-	1	-	1	3
15	Inappropriate motivation of entrants to nursing	1	-	1	-	-	2
16	Confidence	2	9	11	7	5	34
17	Learning from the teacher	2	6	-	-	-	8
18	Tests and exams in bioscience in pre-registration programme	-	1	-	-	-	1
19	Experience	-	6	2	1	2	11
20	Bioscience is scary	-	2	1	-	-	3
21	Nursing terminology	-	1	-	-	1	2
22	Eureka moments	-	1	-	-	1	2
23	Value of bioscience in post-registration programmes	-	1	5	1	1	8
24	Entry gate to nursing	-	-	-	2	-	2
25	Personal motivation of the nurse to learn	-	-	-	2	-	2

The themes that had a great deal of commonality were then identified and a pattern code was applied (see Figure 4.4b). For example the emerging themes of ‘Pre-registration bioscience insufficient for requirements’, ‘Concentration most on anatomy in the pre-registration programme rather than other aspects of bioscience’ and ‘Limitations of pre-registration as preparation for role’ were merged into the pattern code of ‘Bioscience in pre-registration nursing is inadequate’.

Figure 4.4b. Pattern coding.

Code	Pattern code (original descriptive codes shown in brackets where appropriate)	Rationale
a	Nursing is secondary to other professions	Kept as a code as no other similar theme is present
b	Formal education in bioscience is valuable after registration as a nurse. (Education helping the specialist role, Value of bioscience in post-registration programmes, Value of post-registration courses)	Three descriptive codes merged into a single pattern code because of the similarity of the argument
c	Human biology and nursing links	Kept as a code as no other similar theme is present
d	Inadequate bioscience in pre-registration nursing. (Pre-registration bioscience insufficient for requirements, concentration most on anatomy in the pre-registration programme rather than other aspects of bioscience, limitations of pre-registration as preparation for role, quantity of bioscience in the curriculum in pre-registration programmes, fear in an unknown clinical area and reduction of bioscience in pre-registration programme over the years)	Six descriptive codes merged into a single pattern code. Re-examination of the transcripts indicated the common elements to these codes.
e	Learning from colleagues about bioscience	Kept as a code as no other similar theme is present
f	Application of knowledge to practice (Importance of theory to practice links and practice to theory links, experience)	Two emerging codes were merged into one pattern code. The discussion of 'experience' by some interviewees included the idea of 'linking theory to practice'.
g	Knowledge from texts	Kept as a code as no other similar theme is present
h	Entry to nurse training. (Inappropriate motivation of entrants to nursing, entry gate to nursing)	Two codes were merged into a single code drawing together comments about entrants to nursing
i	Confidence	Kept as a code as no other similar theme is present
j	Learning from the teacher	Kept as a code as no other similar theme is present
k	Tests and exams in bioscience in pre-registration programme	Kept as a code as no other similar theme is present
l	Bioscience is scary	Kept as a code as no other similar theme is present
m	Terminology (Nursing terminology and Medical/scientific terminology)	Two codes dealing with terminology were merged into a single pattern code
n	Eureka moments	Kept as a code as no other similar theme is present
o	Personal motivation of the nurse to learn	Kept as a code as no other similar theme is present

Text relevant to each of the pattern codes was then aggregated. The text was read again to see if there was any discrepancy between the text and the code allocated. Where descriptive codes had been merged into a pattern code, any duplicated text was removed. At the stage of pattern coding, all descriptive codes were retained. It was only after this stage, in looking for major themes, that descriptive codes that were not common across the groups, or were not mentioned frequently, were separated from the major themes. The rationale for coding is given in Figures 4.4a, 4.4b and 4.5. This process resulted in the emergence of 5 major themes, these are summarised in Figure 4.5. These themes were explored in the final two interviews.

Figure 4.5. Major themes following pattern coding and analysis.

Theme code from Figure 4.2	Pattern code	Brief rationale for inclusion
b	Formal education in bioscience is valuable after registration as a nurse.	35 separate pieces of text were identified in support of this theme across all 7 interviewees.
d	Bioscience in pre-registration nursing programmes is inadequate.	61 separate pieces of text were identified in support of this theme across all 7 interviewees
e	Learning from colleagues about bioscience is valuable	18 separate pieces of text were identified in support of this theme across all 7 interviewees
f	Application of knowledge to practice is important in learning	35 separate pieces of text were identified in support of this theme across all 7 interviewees
i	Confidence grows with knowledge of bioscience	34 separate pieces of text were identified in support of this theme across all 7 interviewees

Examples of text from the interview transcripts in support of each theme are given in Figures 4.6a – 4.6e. Additional examples of text from the transcript are used as examples within the analysis of results.

Emerging themes

This section explores the significant themes emerging from the results and aims to create a plausible and trustworthy interpretation. Bassey's (1999) recommendations on the construction of the case study have been followed. The analysis and findings are woven together as recommended by major authors on the subject (Bassey, 1999; Bowling, 2002; Gillham, 2000; Eisenhardt, 2002) for the construction of case study.

Five main themes emerged from the qualitative and quantitative results. The inadequacy of bioscience in pre-registration programmes across a range of topics emerged as a strong theme and is considered first as the pre-registration programme is the first nursing programme undertaken in a nurse's career. After registering as a nurse, staff nurses undertake a number of professional development programmes, both work-based and university based. The second theme emerging from the data is the positive value attributed to formal education in bioscience in these post-registration programmes. Three further themes relate to learning, application and confidence. Learning bioscience in relation to practice, learning from colleagues and the increasing level of confidence with increased levels of bioscience knowledge are all significant themes. These themes are analysed, integrating the quantitative and qualitative findings, and then synthesised and discussed. Reflection on the findings from the literature is used in support of the analysis. A synthesis in relation to the main research questions is provided in the following chapter.

Inadequate bioscience in pre-registration nursing

A major theme arising from the interviews is 'Inadequate bioscience in pre-registration nursing'. This theme is also supported in the analysis of questionnaires. Figure 4.2a summarises results from the questionnaires on this topic; 57.1% of respondents (24 individuals) indicated that the bioscience content of their pre-registration programme was limited. This compares with 33.3 % of respondents (14 individuals) who responded that the content was adequate, and 9.5% (4 individuals) who indicated the coverage was

extensive. All those who considered the bioscience content to be extensive were aged 41 years and above (groups d, e and f), and had been nursing over 20 years, suggesting either that older individuals are more able to understand bioscience or have previous knowledge or experience, or that the bioscience content of courses has reduced over the years. Nurses in the lower age groups were more likely to report the bioscience content as 'limited' than 'adequate'. In the 41 – 45 year age group (8 individuals) half reported the content to be adequate, with an equal number (25%) of respondents in both of the other categories. This compares with the 46 – 50 year age group (14 individuals) where there was almost equal likelihood of reporting 'limited' or 'adequate' content, and the 51 – 55 year age group (8 individuals) where 75% reported 'limited' coverage.

In analysing the responses by year group of qualification the most recently qualified were far more likely to report the bioscience content as limited (75% = 9 individuals) than adequate (25% = 3 individuals). No individuals in this category reported the bioscience content as extensive. Wynne et al's (1997) argument that there was a reduction in the bioscience content of pre-registration programmes in the 1990s appears to be supported by these findings. The majority of respondents (85.7%, 36 individuals) indicated that the bioscience content of their pre-registration programme had been linked to practice – with a similar response rate in the 'usually linked to practice' (40.5 %) and 'sometimes linked to practice' (45.2%) responses.

All interviewees identified that there had been insufficient bioscience content in their pre-registration programme. Interviews were across the age range and across the range of years of qualification and included respondents from the range of job roles. Four quotations from the transcripts serve to illustrate the perceived lack of bioscience in pre-registration nursing programmes:

'I feel in nurse training we did not receive enough (biosciences)'

'I think a lot of what we, for me personally and for other nurses that I know, it always seems to be a very superficial knowledge, so we know a little bit about symptoms and the physiology of the illness that the patient has but not the deeper aspects, you know,'

'Yes, but it does not stand out, I don't remember it as standing out, possibly because I had previous knowledge, or possibly because it was not the main focus. I remember doing the finals in my SRN and doing the anatomy of the breast, and it was very superficial.'

'I have no recollection of ever being taught the cardiovascular system but I do remember being taught the nervous system, and the GI tract, but it is strange because we must have been taught it because we had blocks, we had a block when we were in school and we learned about, that was the focus of that particular period in school, but in some areas its completely missing, and I've learned over the years, and I've filled in those gaps'

These findings are similar to those of Friedel and Treagust (2005) who found 81% of students in their survey did not consider there to be enough bioscience in their pre-registration programme. Friedel and Treagust (2005) studied students undertaking pre-registration programmes and their lecturers. Despite finding bioscience difficult, the nursing students found it very relevant to their work in clinical placements and their expectation for learning of bioscience was for a greater breadth and depth than was in fact included in the programme.

The change in content of bioscience over time was summarised by one participant as:

'Some of the newly qualified staff nurses don't have as much biological knowledge as I had when I qualified.'

Trnobranski (1993) and Wynne et al (1997), amongst other authors, have identified the reduction in bioscience content of the curriculum over the years although they did not study the impact of that reduction. The current study suggests that the reduction in bioscience content that has occurred is having a negative impact on preparation for role. Scrutiny of the findings relating the relevance of the different components of bioscience in the pre-registration programme to job role (Figure 4.2b) demonstrates some differences in the views of nurses from different roles. All those participants (100%, 11 participants) who were working in GP practice based roles indicated that anatomy in the pre-registration programme was highly or fairly relevant. This compared to 72.7% of those in hospital based roles and 55.5% of those in community based roles. No reason for this difference emerges from the data, but it may relate to the nature of the role these nurses are performing, for example their role in explaining the anatomy of the airways to someone diagnosed with asthma. Similar findings occurred for the relevance of

physiology. For relevance of both anatomy and physiology the number of nurses from the hospital setting indicating these topics were highly relevant was slightly greater than those in GP settings, but there were more who indicated the topic was only partly relevant, giving a wider range of answers. This may reflect the greater diversity of roles held by hospital based nurses compared with roles within the community or General Practice setting. That is, hospital based nurses may be relative generalists as staff nurses or ward managers, or they may be real specialists such as clinical nurse specialists or practitioners in specialist areas. Practice nurses as a group tend to have their work focussed on a narrower range of areas such as diabetes, asthma, women's health and immunisation, and community nurses tend to have roles related to management of ongoing or long-term conditions.

For the relevance of microbiology, the hospital based and General Practice based nurses demonstrated similar levels of relevance (77.2%, seventeen individuals and 72.7%, eight individuals respectively answering 'fairly' or 'highly' relevant), scoring this item as important but less so than anatomy and physiology. The relevance given to this topic for the community nurses was much lower (33.3%, three individuals indicating 'fairly' or 'highly' relevant). This may reflect a perceived increased likelihood of infection being acquired in a hospital or General Practice centre than in the home setting. Specific data relating to microbiological knowledge of nurses has not been identified from previous studies. Analysis of pharmacology relevance by job role demonstrated that nurses based in hospital or community settings saw this topic as more relevant in the pre-registration curriculum than those nurses based in General Practices. The majority of hospital based nurses (72.8%) and community-based nurses (66.6%) saw pharmacology as fairly or highly relevant compared to 45.5% of General Practice based nurses. This is likely to be in relation to the easier access to General Practitioners for prescription in General Practices and to the importance given to the health promotion role of the nurse in this setting where the emphasis may be on lifestyle or correct use of medication rather than on prescription. Although a number of authors identify that nurses consider more pharmacology knowledge should be included in pre-registration programmes (Friedel and Treagust, 2005; Clancy

et al, 2000; Mooney, 2007), this distinction of perceived relevance of pharmacology by job role has not been identified previously in the literature. For relevance of biochemistry in the pre-registration curriculum by job role, hospital based nurses indicated greater relevance than either of the other two groups with 72.8% of hospital based nurses indicating biochemistry as fairly or highly relevant, compared to 44.4% of community based nurses and 54.6% of General Practice based nurses. Blood and urine test results are probably more often undertaken and more likely to be available in the hospital setting or the General Practice setting. These new findings about bioscience relevance to job role suggest that the pre-registration nursing curriculum may need to be adapted to accommodate the variety of roles registered nurses take up on qualification.

In addition to the lack of content within the pre-registration programme, the lack of knowledge of mentors or nurse lecturers was also identified:

'I went on to the A and E course unfortunately the tutor we had there wasn't very good and was very out of date with current practice and although she was teaching us about the biosciences, she would pepper it with anecdotes about work which were set in a different time, so we actually didn't find her very credible if that is the right word, and also we went through the cardiovascular system and were being taught about things in the heart and I had only just completed the ALS and some of the information we were given wasn't correct, so that, so mentally you think I'm going to look this up myself because I'm not that confident that what she's telling me is up to date knowledge.'

While this is not a major finding from this study, it does support the findings of Hayward and Akinsanya (1982), Clarke (1995), and Courteney (1991, 2002) who acknowledge the lack of bioscience knowledge of those in a position to pass on this knowledge and suggests that there is a major difficulty with registered nurses lacking knowledge of bioscience or confidence in that knowledge. The literature demonstrates that this is a persisting problem. It may be worthwhile undertaking a survey of current nurse lecturers to determine any changes that may have occurred in the UK since 2002 when Courteney's work was published. This topic of bioscience knowledge of lecturers was not specifically investigated in the current study because there appeared to be sufficient evidence already to take immediate action, rather than waiting for a further research study in this area. HEIs would be advised to ensure the nurses they employ to teach on pre-registration nursing programmes are adequately equipped to teach biosciences and understand

the importance of biosciences to students. A specific recommendation from the current study is to advise HEIs to increase the depth and breadth of bioscience learning in pre-registration nursing programmes; the evidence seems to suggest that further bioscience education in the pre-registration programme will lead to improved bioscience knowledge in future generations of mentors and lecturers. The nurses in this study have stated clearly that the current preparation is not sufficient for role.

The answer to the question 'Did the bioscience in your pre-registration course prepare you for your role as a registered nurse?' (Figure 4.2a) showed there to be an equal split between the number of respondents answering 'prepared me adequately' and those responding that it 'did not adequately prepare me' (40.5% = seventeen respondents for each response). Only 19% (eight respondents) answered that the course prepared them well. Those respondents under age 40 had a higher proportion of individuals answering that the course 'did not prepare me adequately' (58.3%) than those aged 41 and above (33.3%). Those nurses who had qualified since 1995 were far more likely to indicate a lack of preparation (66.7%) than the nurses qualified in earlier years (30.0%).

The strength of feeling about lack of preparedness for role came through more markedly in the interviews, with all participants indicating that the pre-registration bioscience content had not prepared them for their role as a registered nurse. Two participants were quite blunt in answer to a question on preparedness for role:

'the simple answer is no, because we had concentrated on the body and how it functioned, not on the disease process of the body,'

'No, no I didn't, I didn't feel that, I felt that there was an awful lot I didn't know,'

Two interviewees expressed the fear they had in new clinical areas because of their lack of bioscience knowledge, one of their statements is provided as an example here:

'I had been onto the ENT ward once before to cover someone's tea break and was absolutely petrified by the whole thing of patients with tracheostomies and that sort of thing and went into that role, that staff nurse job, with a bit of trepidation'

The current study is of experienced registered nurses reporting their pre-registration experiences, that is, the participants are looking back and remembering, and what the participants report may not be completely accurate. While this is not a theme in the methodology literature in relation to case studies, it is raised as an issue with qualitative research in general (Maxwell, 2002) and with certain types of qualitative research, notably ethnography (Van Maanen, 2002). Maxwell (2002) points out the importance of recording what the participant is saying for qualitative research, rather than trying to interpret it at an early stage. This advice was followed in the current study. Van Maanen (2002), in his discussion of ethnographic research, questions whether those who give the researcher information do so truthfully. His view is based on the interviewees' reports of their own behaviour, and the possibility that information will be given to show the interviewee in a more favourable light. Lofland (2002) also discusses ethnographic approaches and the desire of the qualitative researcher to produce data that 'correctly represents the empirical facts of a situation or setting' (p153). He remarks that more attention has been paid to ensuring that what is reported by interviewees is accurately represented by researchers, but little attention has been given to the factual accuracy of what the interviewee is reporting. Triangulation of the data by using mixed methods is recommended in the pursuit of factual accuracy (Lofland, 2002). This has been pursued in the current study by considering data generated from questionnaires alongside data generated from interviews.

Possible concerns about factual accuracy of the data do not appear to be problematic in the current study. Looking at general findings across qualitative and quantitative data in this current study and that of Friedel and Treagust (2005) the lack of breadth and depth of bioscience content, the lack of applicability to role, and the lack of emphasis by lecturers on bioscience are similar themes. The current study is useful in looking at experienced nurses, as there is an implication that the lack of bioscience in pre-registration programmes has a considerable impact on the nurses' ability to fulfil their

roles once registered. For example, one participant identified the lack of ability to undertake her role on a medical ward as a new staff nurse:

'it seems really bizarre that you would be in charge of a medical ward as a staff nurse and not really have that .. I think some of it actually probably was not really relating what I had been taught to practice,

And a mental health nurse identified lack of preparation for role in relation to medications:

'we give a lot of medications for modification of symptoms, but there was never much about the effects or side effects of these medications, how they were meant to work or what to look out for'

This finding of lack of preparation for role is additional to the findings by Friedel and Treagust (2005).

Respondents were asked to comment on the coverage of five different aspects of bioscience in their pre-registration programme and comment on whether they thought the bioscience was relevant for inclusion in pre-registration programmes. A clear trend is evident in the results (see Figure 4,2b). Coverage was seen as greatest (adequate or extensive) for anatomy (61.9%) and physiology (54.7%), with only one respondent indicating 'very limited' coverage of these topics. Responses demonstrated far less coverage (adequate or extensive) of microbiology (11.9%), pharmacology (16.7%) and biochemistry (9.5%). More than half the respondents indicated 'Very limited' coverage of pharmacology (57.1%) or biochemistry (57.1%). Coverage of microbiology was reported as greater than coverage of pharmacology and biochemistry but still poor with 52.4% of respondents stating there had been 'limited' coverage and a further 35.7% indicating there had been 'very limited' coverage of this topic. Those reporting extensive coverage of any of these topics were all in the older age range of 41 years and above and qualified before 1995.

Examination of the responses regarding the relevance of inclusion of the different bioscience topics in the pre-registration curriculum indicates that the respondents saw the topics as relevant, even though coverage was not as great as they wished. The majority of respondents saw inclusion of anatomy and physiology as highly relevant (42.9% and 47.6% respectively) with 76.2%

indicating that anatomy was fairly or highly relevant, the figure for physiology being 78.6%. Microbiology, pharmacology and biochemistry did not score as highly as anatomy and physiology for relevance of inclusion but did demonstrate the majority of respondents considered these topics as fairly or highly relevant (microbiology 66.6%, pharmacology 64.3% and biochemistry 61.9%). Morrison-Griffiths et al (2002) specifically examined the pharmacological content of pre-registration programmes in nursing and found this to be inconsistent between programmes and deficient in relation to need. In the current study, 57.1% of respondents indicated coverage of pharmacology was 'very limited' in their pre-registration programme and 64.3% of respondents indicated they considered pharmacology to be 'fairly' or 'highly' relevant – that is the considerable relevance of pharmacology to the work of the nurse was identified but the pre-registration programme had not recognised the importance of this subject. Nurses in the current study, whatever their current job role, identified a need for a 'lot of knowledge' of pharmacology (Figure 4.2d) with 73.8% (31 individuals) identifying this in relation to their current role. Whilst caution should be applied in interpreting these findings about experienced nurses' current roles in relation to the role of the newly qualified nurse, it can be deduced that if this pharmacology knowledge had not been gained in the pre-registration programme then the newly qualified staff nurse would not be sufficiently prepared to undertake the various roles of the nurse as the career of the nurse developed. The findings here support the findings of Morrison-Griffiths et al (2002) and lend strength to the argument for increased range of bioscience in pre-registration nursing programmes.

The interviews also demonstrated a concentration on anatomy and physiology in the curriculum, although without sufficient detail.

'We did learn anatomy and physiology but it was very much taught with the, there was a tutor there in the classroom, and we all sat there in the desks and there was not very much interaction between, you know like with the Nurse Prescribers we were often given exercises to do'

'I suppose how the bones – I could describe to you the skeleton and the bones that made up the skeleton but actually then how the bone itself like the composition of it or how the bone marrow works or that sort of thing - I probably couldn't at that stage or even now I couldn't describe to you how the skeleton was formed and what the composition of it is and that sort of thing'

'From my point of view anatomy is quite important, but only related specifically to the areas that I'm looking after patients I mean obviously I can vaguely remember, I can remember (from the pre-registration course)where the major organs are I would say my anatomical knowledge is far more detailed if you were to ask me about the voice box and those sorts of things, would be much more detailed.'

Where interviewees described pharmacology, microbiology or biochemistry, it was to state that this content was very limited or absent from the pre-registration programme.

(In describing what would have been useful in the programme) 'Looking at blood gases for instance, something that has always for me been, completely, difficult for me to understand.'

(from a mental health nurse) 'we give a lot of medications for modification of symptoms, but there was never much about the effects or side effects of these medications, how they were meant to work or what to look out for'

'when I finished my training that I had a hugely broad well I suppose I did have a broad knowledge but I felt that it was quite, sort of, I don't know how to describe it , I knew a lot of things about a lot of systems but I never felt I knew anything in depth, for example it is only recently I have been able to get my head around blood counts and things like that, so I felt like I knew a lot about a lot of things but nothing very deeply.'

The importance given to anatomical knowledge by students of nursing was identified by Courteney (1991); she also noted a lack of overall bioscience content in pre-registration curricula. Leathard (2001) and Mooney (2007) identify the difficulties nurses have with administration of medicines when they first register. However, there is limited other literature to give background to these findings about different topics of bioscience knowledge. Danielson and Berntsson's (2007) study of Swedish registered nurses three years after qualifying demonstrated that the nurses considered bioscience and medical science (including anatomy, physiology, microbiology, pharmacology and biochemistry) to be the most important area of knowledge to help them carry out their roles, rather than social and behavioural science, or even in some cases nursing studies. This finding is supported in the current study.

A question was also posed on the questionnaire regarding whether teaching on pre-registration programmes had helped the learning of bioscience. The focus here was not the content, but the teaching of bioscience. Results show (Figure 4.2e) that the majority of respondents found that the teaching did help (28.6%) or helped quite a lot (35.7%) with a further 11.9% indicating it helped

a great deal, although 23.8% of respondents stated it either did not help or only helped a little. The majority found the teaching helpful, but in comparison to the other factors that helped the learning of bioscience, this item scores the lowest, with teaching on post-registration courses, books and the internet, discussion with colleagues, and experiences at work all being more helpful than teaching on the pre-registration programme.

An interesting finding is that what was being taught does not appear to have been sufficiently related to the real work of nursing. That is, bioscience teaching was applied to practice, but not in a meaningful way. It appears that reference was made to practice during the teaching of bioscience (40.5% of respondents indicated teaching was usually linked to practice, Figure 4.2a) but the references made did not link sufficiently with the role of the nurse at registration (40.5% of respondents indicated the bioscience in pre-registration programmes did not prepare them well for their role as a newly qualified nurse). A quotation from one of the transcripts encapsulates this:

'…but I didn't really understand that at the time, it seems really bizarre that you would be in charge of a medical ward as a staff nurse and not really have that .. I think some of it actually probably was not really relating what I had been taught to practice, so I probably did know that but not putting that with the patient and coming up with, you know, thinking about what would happen to the patient.'

The ability to transfer learning into the real world of nursing appears to be deficient in the pre-registration programmes. Wilson (1975) was the first to identify that teaching during pre-registration programmes did not match the needs of newly qualified nurses. In her observational study of staff nurses, Wilson (1975) identified a lack of bioscience knowledge in staff nurses in relation to the work they were carrying out and the knowledge expected of the nurse by the doctor. Other more recent authors have produced similar conclusions. For example Davies et al (2000) identified that students wanted more application of bioscience and Clancy et al (2000) identified the lack of ability of newly qualified staff nurses to apply their bioscience knowledge in the practice setting. The findings in the current study support earlier work by these authors and this issue is examined further under other emerging themes.

Additional examples of sections of the interviews supporting the theme of ‘Bioscience in pre-registration nursing programmes is inadequate’ can be found in Figure 4.6a.

It is clear that the nurses in this study lacked both bioscience knowledge and confidence in that knowledge when they first registered as a nurse. The pre-registration programmes undertaken by the nurses in the study have not prepared them adequately in the biosciences for their roles as registered nurses.

Figure 4.6a
Additional examples of sections of the interviews supporting the theme of 'Bioscience in pre-registration nursing programmes is inadequate'

When I finished my training that I had a hugely broad well I suppose I did have a broad knowledge but I felt that it was quite, sort of, I don't know how to describe it, I knew a lot of things about a lot of systems but I never felt I knew anything in depth, for example it is only recently I have been able to get my head around blood counts and things like that, so I felt like I knew a lot about a lot of things but nothing very deeply.

I found when I was doing my nursing course, doing the anatomy and physiology side it was like visiting an old friend. This time when I looked at chemistry I thought yes I can actually make sense of this and if we touched on physics I am not really aware so long as it was not Boyle's law, I did not care, that was my attitude, and I did very well on the anatomy and physiology, I feel in nurse training we did not receive enough. I also feel we did not receive enough in terms of relating it to the disease process in the body we just learned it as how the body works.

We have student nurses that work with us, and very often because I work in the heart failure service, their understanding of the heart and how it works is extremely limited. But even where some of them do understand how the heart actually works I can see that they haven't got the link between that and the disease processes

---

I don't think so, I can't recall ever doing anything in that detail in my pre-registration training

---

(In relation to whether she was prepared for her surgical role) no, working on the ward it is a very demanding ward, and very fast paced and the simple answer is no, because we had concentrated on the body and how it functioned, not on the disease process of the body, so it was the malfunction of the body we need to look at in far greater detail and what that impacted in terms of how it affects the entire body system.

I think I did not realise it was delivered at all when I trained, it is very, it doesn't, for some people they had done A levels, but I don't think it was done to any great degree.

Very much not, the second part you are saying, very much not linked to practice. I think A and P we did it in one term, or half a term, because I did the last of the Project 2000 intake and we were given a workbook and it was up to us as to how much work we put into it and, which is fine, that is what university is about, but having said that, what we were never asked to do was to make that link between practice and theory, it was more about, you had a workbook, could you achieve a good mark? Yes. You went on the wards and nobody asked you did you relate what you had learned to what you were practising. And I still don't think that link is sufficiently sorted.

Formal education in bioscience is valuable after registration as a nurse.

This theme emerged from the interviews but had only been explored in one question on the questionnaires. Response rates are shown in Figure 4.2e. 73.8% of respondents (31 individuals) indicated that teaching on post-registration programmes had helped a great deal (16.7%) or helped quite a lot (57.1%). A further 19.0% (8 individuals) responded that post registration programmes had 'helped' the learning of bioscience.

Interviewees volunteered positive comments on the extent to which post-registration programmes had assisted in the learning of bioscience.

Interviewees commenting on in-service courses:

'I found that extremely helpful, that is based on scenarios, it is based on the principles of recognising when life threatening situations are happening and the cascade of what you would do, and very simple technique, that I found very effective, because instead of leaving lots of grey areas it broke it down into ABC steps, OK, so it was like giving you a crib sheet, not saying that there wouldn't be deviations, but at the same time it gave you what steps you should work through. And the second course I did was the critical care course again when I was still on X ward and I found that extremely good, I did it on …. septic shock I think, you had to look at the cascade of what was going on in terms of sepsis looking at the biosciences the anatomy, the disease process, the effect it had on people, age related, gender related, that sort of thing.'

(Commenting on an in-service course in relation to the job) 'you have to understand how the heart works and the whole pumping mechanism of the body, you know, cardiac output, preload, afterload, those sort of terms, and that made me look more at A and P, that was probably the first visit to A and P, truly, after I had been qualified for about 2 years at that stage'.

And commenting on formal higher education courses:

'Yes, well obviously having just done the Nurse Prescribing course I have had to learn quite a lot about pharmacology and how drugs work and how the body works on drugs and how drugs work on the body, and that's quite important, and obviously from a, I have had to learn, about the microbiology, the histology and microbiology side of things really as I said earlier getting my head around the different diffentiations of the cells and that sort of thing and different types of tumours and how you can see what is happening in the cell determines what type of tumour it is and that sort of thing'

'I think the coronary heart disease course has an expectation of basic knowledge being in much greater depth than I had at the time'.

References to the lack of bioscience in earlier diploma or degree programmes but the increasing focus on bioscience in the Nurse Prescriber and Masters courses was summed up by two interviewees:

'No, well, very scanty, very superficial, I think all nurse courses are now, they don't seem to have any science in them lots of social, law, very vague, its quite nice to get back to a course which you thought was practical because it really was scientific rather than vague.'

(In answer to the question, was there any bioscience in your courses?)'I suppose a bit on the oncology and ENT courses I have done but I would say the Diploma I did was very airy fairy wishy-washy it was lots of sociology psychology that sort of stuff not a biologically based diploma …… My BSc although it's in health studies and there were, I am trying to think of the modules that I did on my BSc now, was there anything that was bioscience related. Not really, that I can recall, whereas on the MSc … there was biological sciences, one of the modules was that'

Jordan and Reid (1996) found that students on their post-registration programme considered the bioscience content to be very valuable and to have contributed to improvements in patient care. Their study differed from the current study in that they looked at the influence of a single post-registration programme, whereas the current study asked about all post-registration programmes.

While the value of post-registration programmes in helping to learn bioscience emerged as a theme in its own right, there is clearly a link to the next theme, application of knowledge to practice, as many participants indicated the courses were valuable because they were embedded soundly in practice. One interviewee illustrates this:

'But that is when I really thought actually there is more to things than just seeing the surface of what we do as nurses when you actually undertake a course like that, you are then told 'you can run a cardiac arrest without a doctor being there', and then you are thinking 'I am going to be the one analysing the blood, I am going to be the one saying this is the drug that you give' and you realise the enormity of the responsibility that you have and the amount of knowledge that you need to back up if you are going to use a particular drug or whatever'

Additional examples of sections of the interviews supporting the theme of 'Formal education in bioscience is valuable after registration as a nurse' can be found in Figure 4.6b. The breadth and depth of bioscience knowledge held by nurses is clearly improved by formal education in post-registration programmes. Jordan and Reid's (1996) study demonstrated the increased confidence nurses had as a result of post-registration tuition in bioscience. This finding was supported in the current study and is discussed under the theme of 'confidence' below.

Figure 4.6b
Additional examples of sections of the interviews supporting the theme of 'Formal education in bioscience is valuable after registration as a nurse'

Now I am doing a Masters, Long Term conditions, and the Nurse Prescribing and from the bioscience point of view by far the most in depth course was the Nurse Prescribing because we revised everything.

It is a long time since I have actually had anyone giving me that information and understanding it more because of the knowledge I have gained over the years in the clinical setting and through my own reading so some of the things, you suddenly have that 'ah ha', when you think 'now I know, I understand that now, I've read about it and didn't really understand it but now' I can't think of any examples but it did happen in the classroom, but you suddenly thought 'oh yes of course that makes sense now' and ..

Until that time my knowledge had been knowledge that I had gained in practice but then I had to go on to courses and I had to demonstrate that knowledge and I think that, once you get into an advanced role you suddenly find how little you know, ..

I think it is first and foremost it has given me a far greater sense of responsibility, responsibility for myself, responsibility for other people.

Looking at things from a bioscience aspect I would say it was the nurse prescribing, you did find you had got something back in there, it was a long time ago but you could get it out again, so it made more sense of things. For me it is the best course I have ever done.

Application of knowledge to practice is important in learning

An emerging theme through the interviews was the importance of learning by applying to practice. Two areas of the questionnaire had made reference to this theme. An overwhelming majority of respondents (85.7%) indicated that the teaching of bioscience on pre-registration nursing programmes was usually (40.5%) or sometimes (45.2%) linked to practice (Figure 4.2a). Only 14.3% indicated that the bioscience was rarely linked to practice. Analysing the responses by year of qualification does indicate that the more recently qualified (since 1995) were more likely to answer that the 'bioscience was rarely linked to practice' and less likely to answer that the 'bioscience was usually linked to practice'.

In the interviews, the importance of the links to practice in the learning situation and the lack of substantial existing links emerged as a theme.

Numerous responses indicated a disappointment with the lack of relationship between theory and practice:

'Yes, but I wasn't instructed in that. I learned later more about the physiology of it, I would have acquired later, I realise that you know things basically and then you add a bit on.'

'Very much not, the second part you are saying, very much not linked to practice. I think A and P we did it in one term, or half a term, because I did the last of the Project 2000 intake and we were given a workbook and it was up to us as to how much work we put into it and, which is fine, that is what university is about, but having said that, what we were never asked to do was to make that link between practice and theory, it was more about, you had a workbook, could you achieve a good mark? Yes. You went on the wards and nobody asked you did you relate what you had learned to what you were practising. And I still don't think that link is sufficiently sorted'.

'Yes but it was almost like that belongs to the classroom and this is the patient and where do they meet together?'

The importance of embedding learning in practice is a major theme in many theories of learning. Adult learning theory was developed in relation to the broad subject of learning by adults and is not specific to learning of bioscience by student nurses (Quinn and Hughes, 2007). However, all students of nursing are adult, and consideration of adult learning theory is applicable here. Knowles et al (2005) identified the importance of adult's learning in relation to what they need to do, that is their job roles. In this

study adult learning theory is applicable, as students of nursing need to learn in relation to the role of the newly qualified staff nurse, assessing patients conditions, solving problems patients present with, and undertaking clinical skills. Quinn and Hughes (2007) see this learning by adults as very different from the way in which children learn, with children learning subject matter without grounding this in experience or work roles. It would appear that in the current study, nurses were taught bioscience in their pre-registration programmes using pedagogy (learning theory applicable to children) rather than andragogy (adult learning theory). The subject matter of biology had been presented, but not been made relevant to the clinical situations in which the knowledge would need to be applied. The findings clearly suggest a need for learning of bioscience in relation to specific clinical situations.

Respondents were able to explicitly identify bioscience learning in post-registration courses that had directly linked to the job role

'Yes, it was doing the two things together, and it is also being inquisitive, and the experience even though it isn't written down any more, the experience because you had seen it before.'

'Yes, because it made it, partly because if you look in the renal bit at the back of the BNF, you have to apply that, and then you have to actually apply meaning to that'

The respondents also identified the need for bioscience in relation to the practice setting, where a lack of that link had made it difficult for them to do their job.

'…I remember being on night duty when a patient started bleeding. I knew by looking at the patient that something was wrong, and I suspected bleeding, but the patient did not have a wound so I was really, I couldn't make sense of the situation, I was trying to think about what else apart from bleeding could be causing the patient to be like he was. I felt so stupid because I should have linked the patient's condition with their likelihood of an intestinal bleed, but I just didn't, it made sense afterwards but at the time it made me realise I wasn't doing the job I should be doing, I mean I should have been looking out for that. I knew about bleeding but I didn't apply it'

The significance of the practice setting in which the nurse is working is highlighted by Dart (1997). He discusses the way in which current needs of the adult learner and their existing experience are crucial in selecting new information to learn and constructing new knowledge. This is evident in the nurses undertaking post-registration programmes, the specific learning based on experience and preparing them for further roles is significant.

The questionnaire explored the quantity of bioscience knowledge needed in relation to the job role across anatomy, physiology, microbiology, pharmacology and biochemistry (Figure 4.2d). A large majority of respondents indicated that they needed 'a lot of knowledge' of anatomy (71.4%), physiology (66.7%) and pharmacology (73.8%) in relation to their role. Results indicate that respondents considered they needed at least some knowledge of microbiology (54.8%) and biochemistry (52.4%) but less knowledge of these subjects than of the others.

The question had been asked in relation to the respondent's current job role, the results were cross-tabulated by job roles (Figure 4.2d). Those in GP practice based and hospital based roles had a greater proportion of respondents answering that they needed 'a lot of knowledge of anatomy' (81.8% and 77.3% respectively) than those in community based roles (44.4%), but all three categories of jobs scored highly overall in this area when answers of 'some knowledge needed' and 'a lot of knowledge needed' were combined. It could be that the nurses working in hospitals and GP practice settings were dealing with a greater range of conditions in their patients than those nurses working in the community, but this has not been explored in the current study. Results by job role were almost identical for the question asking for the amount of physiology needed in relation to the current job role although for those in hospital based roles 68.2% (15 respondents) indicated they required 'a lot of knowledge' of physiology where 77.3% (17 respondents) stated a need for 'a lot of knowledge' of anatomy.

The results across all three groups for the need for pharmacology in relation to current job role was highly positive: 68.2% of hospital based individuals; 77.8% of community based individuals; and 81.8% of GP practice based individuals demonstrated that 'a lot of knowledge' was needed in this area.

Need for knowledge of microbiology in relation to job role was slightly stronger for those working in GP practice settings than those in other settings with 54.5% (6 individuals) reporting a need for 'a lot of knowledge' in this field. For biochemistry knowledge, those working in GP practice settings were

again more likely to report a need for ‘a lot of knowledge’ (63.6%) than those working in hospitals (40.9%) or the community (22.2%).

Figure 4.2e reports the findings from the questionnaire item of whether experiences at work had helped the learning of biosciences. The majority of respondents (61.9%) answered that these experiences ‘helped a great deal’. This is a powerful argument in support of the need to embed the learning of bioscience into the practice setting.

Additional examples of sections of the interviews supporting the theme of ‘Application of knowledge to practice is important in learning ’ can be found in Figure 4.6c.

Experience is clearly an important factor in the learning of bioscience and has been identified by several authors (Benner, 1984; Eraut, 1997; Jordan and Hughes, 1995; Davies et al, 2000). Experience does not appear to be just about time served as a registered nurse. Rather, experience contributing to learning of bioscience is about exposure to a range of diseases and treatments in nursing patients. There is clear evidence in the interview transcripts that interviewees in this study did not learn their bioscience knowledge during pre-registration nursing programmes in relation to the experiences they would encounter when they registered and had to work independently as a nurse. The interviewees had learned some bioscience in their pre-registration programme, but this was not sufficiently embedded in practice to enable it to be useful on registration. Benner’s (1984) view of the development of the expert role takes into account experience and additional learning; this study was not focussed on bioscience, but on the nurse’s role and development once registered. However, the current study appears to demonstrate that Benner’s work could be applied to the learning of bioscience. Davies et al (2000) demonstrated that students learned bioscience more thoroughly if it was embedded in practice. The results from the current study indicate that learning in pre-registration programmes about bioscience was helpful, but did not sufficiently prepare the student for the clinical role of registered nurse. Previous research does not identify the

strength of the role of experience in learning bioscience when compared to classroom learning or other forms of learning. This study suggests that experience is a very strong factor for learning of bioscience by nurses.

Figure 4.6c
Additional examples of sections of the interviews supporting the theme of 'Application of knowledge to practice is important in learning'

You have to attach it to a real situation, if they are learning things for the sake of it about systems, not applied, it is very difficult to remember – I liked diagrams – like the steroids with the fat man and big tummy, it is easier to apply.

We are not always supported in making that link, that is the first thing, the second thing is some of us are very good at doing that, others, it is like any gift you have some people are highly gifted in a particular area and can make links very easily, other people have got a gifting but they just need a little bit more educating, leading out, education means leading out anyway, showing them how they can make that link first of all and then allowing them to go and do it. I know that is a difficult area because you can only learn because it has cropped up in your practice, you can't teach people everything in anticipation that they might come across it.

Yes, yes, because it made sense, when you are being told about the lens in the eye, until you see it, you don't know what it is, you can imagine it, but ..

I have learned a lot more through trial and error in the clinical situation and again its like, it's a situation where you have learned something but actually seeing it and suddenly there is this connection between what you have learned and what you see.

I suppose about seeing, seeing the healing process taking place, going to see a patient, and going back to see the patient a week or two later, seeing the changes in the wound. Being told what granulation tissue looks like, or slough or necrotic tissue, its not the same as actually seeing it and touching and feeling it for yourself. So now I have smelt it, I have seen it, and I know it, but when you're reading, or, it is that visual thing with me that helps me to remember. A patient would help me to remember a fact about, because of the clinical signs that the patient has had will help me to remember what is happening with the physiology of that patient.

Yes, it is about the interaction with the patient. It is the patient that is telling you what the signs are. One of the signs of a wound infection, apart from the obvious systemic signs, is that they have an increase in pain, and when you see a patient with a pressure ulcer for example and you see them with no infection, and again a week later and the nurses are telling you the patient is crying out in pain and the dressing has been difficult to do and you see the difference between what the wound looked like a week ago and what it looks like now and what the patient looks like, the patient is not eating and is feeling terrible, then you, that clinical picture indicates this is the patient with a wound infection.

Learning from colleagues about bioscience is valuable

This theme had been explored in only one item on the questionnaire (see Figure 4.2e), which asked whether discussion with colleagues helped the learning of bioscience. Responses to this item demonstrated that 40.5% of participants found this 'helped quite a lot' and a further 31.0% indicated it 'helped a great deal'. The strength of response that discussion with colleagues 'helped a great deal' is greater compared to 26.2% indicating books and the internet 'helped a great deal' and 16.7% indicating that teaching on post registration courses 'helped a great deal'. Although combined results for 'helped quite a lot' and 'helped a great deal' do not show differences between the help provided by post-registration courses (73.8%), books and the internet (71.4%) and discussion with colleagues (71.5%), a trend is observed when the results are considered separately. For this group of Nurse Prescribers, the least helpful way of learning bioscience was from pre-registration programmes (35.7% helped quite a lot/11.9% helped a great deal), followed by slightly more help from post-registration programmes (57.1% helped quite a lot/16.7% helped a great deal), and more still from books and the internet (45.2% helped quite a lot/26.2% helped a great deal), greater help again from discussion with colleagues (40.5% helped quite a lot/31.0% helped a great deal) and most help from experiences at work (31.0% helped quite a lot/61.9% helped a great deal). These results indicate that formal teaching was least helpful and informal teaching most helpful in learning bioscience. From the questionnaires, experiences at work helping the learning of bioscience is seen as a far more important factor with 61.9% indicating this 'helped a great deal'. The results from interviews agree in the view that informal methods are more helpful than formal teaching for learning bioscience, but do differ from the results from the questionnaire as the interviews indicated greater importance was given to the support of colleagues in helping their understanding of bioscience rather than their work experience. All interviewees spoke very strongly about the important influence of colleagues in helping them to learn bioscience. The role of experienced nurses, particularly in specialist areas of work, was seen as important in helping learning of bioscience. Four elements of the transcripts

from two interviewees had indicated help from nurses in learning of bioscience.

'Actually yes, that was really interesting, because it was a speciality, the sisters there were really good, and they taught me about the eye, they gave me information, they taught me about the anatomy and physiology'

(about a sister in Accident and Emergency) 'She was very eccentric but she did actually explain why we were doing things. And some of what she taught us is still relevant today the treatments have changed but some of the very basic things haven't.'

Although some interviewees indicated that nurses did not often have the necessary knowledge to provide assistance:

'I think one of the best things I have done was working with the consultant on the Nurse Prescribing course this time, we had so many discussions, so many things I learned on the ward rounds I did with him I have found I have to say that in all that I have learned along the way I have probably learned, not very nice to say but it is true, more from my discussions with the consultants than with my nursing colleagues'.

The view that medical consultants had been influential in helping the learning of bioscience was much stronger. Ten separate elements of the transcripts across all interviewees identified learning from consultants:

'I suppose a little bit about what I have read but probably a lot more about my experience and talking to other people and working closely with chemotherapy consultants and chemo nurses and learning more from them rather than what I read in the textbook'

'some of my knowledge has come again from reading textbooks and looking at pictures and stuff, a lot has also come from listening in to consultants and being in when they are explaining to patients or the consultants actually explaining to me what they can see'

'There was a particular consultant that was very good at teaching the house officers and when he came on the ward round on X, I would try and be with them and he also welcomed questions from any member that was on tour with them round the ward and he would go back into the treatment room after and discuss with them a variety of things which was good. I learned quite a bit from him in terms of, medication, and why we use a particular drug in a particular way, what the research was saying, what the figures were, and just simple things like chest infections'

'and the consultant would look down with a nasendoscope have a look at their voice box, and then I would say 'what's that bit and what's that bit' and they would talk me through it as well as listening to them explaining to the patients'

'it was that sort of thing I would bring up for discussion with the consultant and I think that I found they also responded a lot better because they felt (a) you were trying to learn and (b) you were up for discussion and (c) they knew what you were asking'

This theme is not evident in the literature and does not yet appear to have been the subject of research. Latter et al (2007) note the role doctors are expected to play in formal supervision of Nurse Prescribers during their programme, but identify the lack of research in this area. Interviewees made a number of references to the different model of the Nurse Prescriber

programme, with a move back to the medical model, that is, with a focus on disease rather than on holistic care. For example:

'You realise that you have experience of a situation but you never actually put the nuts and bolts together with it, so things like, things that are more talked about, like renal function is the first thing because you work out the EGFR on everybody. It is also because I look at patients differently, focussing much more on almost being in a medical model, before you were firmly in a nursing model, so if you are in a medical model, you have to think more that way.'

Additional examples of sections of the interviews supporting the theme of 'Learning from colleagues about bioscience is valuable' can be found in Figure 4.6d.

Wynne et al (1997) discussed the negative views of the medical model by nurse educationalists in the 1980s and the move to a more holistic and behavioural model of nursing. This was despite Wilson (1975) advocating the continuation of at least some aspects of the medical model of disease focus in pre-registration learning. Trnobranski (1993) also commented on this and suggested that negative effects had occurred with the wholesale move away from the medical model of disease and cure to a model of care. Bradley et al (2006) have identified the need to incorporate a medical model with learning about disease processes if nurses are to be successful prescribers. Thus some aspects of a medical model appears very suitable to the Nurse Prescriber role, but is not the model used in pre-registration programmes and consequently nurses have insufficient grounding in relevant bioscience when they enter the Nurse Prescriber programme. The literature does not indicate that a model of holistic care should exclude some elements of learning about disease processes using a medical model, although the two models do tend to be dealt with as separate entities. The expertise of the medical consultants appears to have been useful in helping the nurse to understand the bioscience but there also appears to be a sense of increased motivation for further learning as more is understood and confidence is built.

Figure 4.6d

Additional examples of sections of the interviews supporting the theme of 'Learning from colleagues about bioscience is valuable'

I think one of the best things I have done was working with the consultant on the Nurse Prescribing course this time, we had so many discussions, so many things I learned on the ward rounds I did with him I have found I have to say that in all that I have learned along the way I have probably learned, not very nice to say but it is true, more from my discussions with the consultants than with my nursing colleagues.

Yes, yes, I find, yes I have, I find there are people, you respect their knowledge and you respect their experience, and they tell you something and you think that I will remember that because they have told me that,

---

I have learned from colleagues, I have.

I got some back up on that (from a colleague), on how you manage this chap, that is the practical application of it, but when you learn it as a fact it does not quite apply.

I used not to be confident about listening to people's chests, suggesting they might have an effusion – getting someone to say you have got it right and check you have got it right

---

A lot was in General Practice where you could say to a GP I need to see these things, and he would say go and see these three patients and tell me what you find.

They would include me in their clinical meetings. I work for three practices and two of them have clinical meetings, so that was quite educational,

---

I am studying myself, of how to read and interpret an ECG and then one of the things I find really difficult, I don't always know if I am on the right track because I don't have someone with me mentoring,

---

Confidence grows with knowledge of bioscience

Respondents were asked about levels of confidence in two parts of the questionnaire. Figure 4.2c summarises the findings for level of confidence at the start of the Nurse Prescriber programme across the five identified topics within bioscience. Figure 4.2d summarises level of confidence in relation to current role across these same five topic areas. The majority of respondents indicated they had 'some confidence' in all five topics of bioscience identified. Confidence in anatomy was strongest (26.2% answering 'confident and 66.7% of respondents indicating they had 'some confidence'). This was followed by confidence in physiology (11.9% answering 'confident' and 73.8% 'some confidence'). The answers for microbiology, pharmacology and biochemistry indicated similar levels of confidence across these three topics but lower levels of confidence in these topic areas compared to anatomy or physiology. Analysis of these results by job role suggests that hospital based nurses are more confident in their knowledge than those nurses based in GP settings, who are in turn more confident than nurses in other community settings (no nurses in the hospital or GP practice based roles gave a response of 'very little confidence' for anatomy and physiology). The results for microbiology show great similarity across all three job roles with 50.0%, 55.6% and 54.5% of respondents from hospital base, community base and GP practice base respectively answering they had 'some confidence'.

Confidence in knowledge of pharmacology by job role at the start of the Nurse Prescriber programme is slightly stronger for the community based nurses with 77.8% expressing 'some confidence' or 'confidence' in their knowledge compared to 63.6% of those working in GP practices and 54.6% of those working in hospital based roles. In analysing the results for level of confidence in pharmacology knowledge in relation to current role, there is less difference between the three job roles. A relative lack of confidence in pharmacology in those nurses working in hospital settings may simply reflect the work environment, where there is easier access to medical staff for prescription and information about medications and less reliance on the nurses' own knowledge. Bradley et al (2006) state that most nurses entering

a Nurse Prescriber programme will identify a lack of pharmacological knowledge, although some lecturers felt the knowledge was present but confidence in use of the knowledge was lacking. There is some concern though that this difference in results for hospital and community nurses could indicate that nurses in hospital settings are following doctors' orders in relation to pharmacology rather than thinking for themselves in relation to the patient's specific needs and responses to treatment. It could of course also be the case that nurses in hospital settings tend to deal with a far larger number of medications as part of the treatment regime for patients and therefore the knowledge base required is greater. Studies of nurses' pharmacological knowledge are limited, and only hospital based general nurses feature significantly in these studies. Wilson (1975) identified a knowledge deficit in ward based staff nurses in relation to knowledge of their responsibilities to ensure sufficient blood concentration of drugs, and knowledge of drug calculations. Eraut et al (1995) identified the role of surgical nurses in use of pharmacology knowledge for initial assessment of patients and in the administration of a range of medications, and in administration of anti-emetics in patients with chronic renal failure. However, no comparative studies appear to have been undertaken to determine the extent of pharmacological knowledge used by nurses in different settings. This appears to be an area that could be explored in further research.

Bradley et al's (2006) paper did identify that the manager had 'sent' some students on Nurse Prescriber courses without understanding the commitment required for the course. Elements of this could be present in the cohort in this study and could have led to unrepresentative responses. Bradley et al (2006) also identify that earlier Nurse Prescriber programmes attracted mainly those nurses working in primary care, which is outside the hospital setting, and only more recently have nurses from hospital settings been attending Nurse Prescriber programmes. The same study indicates the need for the Nurse Prescriber programme to prepare both for independent prescribing and for supplementary prescribing, and the different focus this means for different students.

For confidence in biochemistry knowledge, the nurses in community-based roles expressed less confidence (44.4% indicated 'some confidence and 0% indicated 'confidence') than either the nurses with GP practice based roles or those with hospital-based roles (both groups had 63.6% of respondents expressing 'some confidence' or 'confidence'). This may well relate to the increased accessibility to and use of biochemical results by those nurses working in GP practice setting and hospital settings. Results are commonly available via computerised systems and, in the author's experience, access to computers by community nurses is less extensive than for hospital or GP based nurses.

Overall results (Figures 4.2c and 4.2d) showed greater confidence in relation to current role than confidence in general at the start of the Nurse Prescriber programme. Nurses in community-based roles indicated slightly less confidence in their knowledge of anatomy and physiology in relation to their current role than the two other job roles.

Confidence was a strong theme emerging from the interviews. All interviewees expressed the increased confidence in bioscience knowledge in relation to their role as a result of University courses they had undertaken. Several nurses indicated that their experiences through the work place had given them increased knowledge, but it was not until they had undertaken the formal education programme that their confidence in their knowledge increased. Three quotations illustrate this point:

'Before I felt I was much more guessing in the dark, very often it was an educated guess, a good guess, but after doing the course where I was guessing in the dark before there was a light and I could see much more clearly why I was doing it, and also I was much more able to say to the doctor 'I need you to come because..' and 'I think we ought to have' there were times when I would say 'I have already put up …' whatever.'

'And after seeing it once and then saying to the doctor, this is only a very small pressure ulcer, it does not appear to be infected, but I think this patient has a deep seated infection, somewhere, as a result of that and being brave enough to say to the consultant I really think you should do an MRI scan because what I am seeing in this patient I have seen in a couple of other patients and then when you are proved right you think, OK, there is a patient there, but you think actually, I have picked that up because I've seen it before, whereas the junior doctor has not necessarily picked that up because they have not seen it before.'

'When I was working as a nurse practitioner in A and E I wasn't a prescriber, and now I am going to go into a new role as a new prescriber and I do find that quite alarming because it was easy for me as a nurse practitioner previously to just say to the doctor 'can you write that

patient up for Ibuprofen, .. they need some Flucloxacillin, ..they need this' and the doctor just doing it, to me actually thinking about what the patients symptoms are, what my diagnosis is, and actually treating them with drugs.'

The variety of responses indicated that there had been an increase in the nurses' confidence in a range of situations as a result of formal education in the biosciences. This included confidence in skills:

' I used not to be confident about listening to people's chests, suggesting they might have an effusion – getting someone to say you have got it right and check you have got it right'

'I treat it as if I was going to prescribe and it has given me a greater confidence in my ability to diagnose something, to actually look at it in terms of the entire body and to work within my area of speciality, I feel quite comfortable with that.'

And confidence in communicating and dealing with patients and relatives:

'I think some of them (patients) will present to you, they will phone you up, they say they are feeling a bit sick and when you go round there they have lost one and a half stone. Now I've got to the stage I will do the blood test get the results back and discuss it with the GP and say 'you are seeing them tomorrow', whereas before I would have sent them for (referral).'

'Yes, and also they (the relatives) have confidence in you, because they will ring up and say, when you are running a situation, like looking after a patient, and they say 'I think mother has gone demented' and you say, actually if you get a specimen of urine I think you will find she has only got a urinary tract infection.'

'I have always been very willing to suggest it, but now I feel I can explain to the patient more why we are giving it. In the past I just said 'we are going to give you this antibiotic' but now I can explain, in I hope terms they can understand and explain to them if they say to me 'Why are you giving me an antibiotic, I have not got an infection' because they don't associate the smell in the fungating tumour with an infection, so they can't understand why we're giving them an antibiotic, so now I can explain to them why.'

And confidence in communicating with the doctors:

'I now feel more confident to ring up a consultant and say, 'this is the situation' and say 'my patient can't get to outpatients' instead of a doctor doing it, I wouldn't have felt confident enough before.'

'being able to see its signs and symptoms, how it would manifest itself, when to call a doctor, when to, what it gave me was a rationale to be able to relate, not just 'gosh maybe I should call a doctor' it was 'I should call a doctor because …' that is the difference, because I could actually say 'I'm calling this doctor because …'

In addition, there was an increased willingness to admit when the nurse lacked knowledge:

'I don't know, because I think you don't like to admit you don't know. And when you get to my stage in my career I am much more nervous about undertaking new things and I am much more likely to say 'I don't know that''

'Both, I am more confident that I know a bit of it, so then you are more confident to ask without feeling a complete wally.'

Some comments identified a greater satisfaction from the increased knowledge:

'I have changed since I have done my courses, I lacked confidence in my attitude to it, I have gained confidence. I could not go back to being a district nurse, I would be frustrated at what I was not doing'

Additional examples of sections of the interviews supporting the theme of 'Confidence grows with knowledge of bioscience' can be found in Figure 4.6e.

Certainly Jordan and Reid's (1996) action research study demonstrated the increased confidence that resulted from nurses undertaking a post registration programme in bioscience. This confidence was demonstrated in better understanding of treatments and improved ability to communicate with patients about their condition and interventions, and hence better patient care. Bahn (2007) explored registered nurses motivations for undertaking further academic courses and reports an unexpected finding that the nurses gained in both personal and professional ways with a sense of being able to achieve more. In their editorial piece, Draper and Clark (2007) note the lack of sufficient rigorous research into the effectiveness of CPD programmes. Jordan and Reid's (1996) study reported the effects of a single programme of study, this contrasts with the current study that asked about all programmes the nurses had undertaken since registration as a nurse. The findings from the current study are broader and more detailed. The move from tacit knowledge to explicit knowledge is described by Eraut (1997) and involves developing confidence in the knowledge held so that the knowledge can be easily communicated and reflected upon. This appears to have occurred in nurses in the current study, with the move from tacit knowledge to explicit knowledge being through experiences at work and learning from colleagues. Many of the responses shown above indicate an increasing confidence in and willingness to use bioscience knowledge. The interviewees indicated a far greater respect for medical staff and also a far greater willingness to communicate with them in discussion of patient cases.

Figure 4.6e

Additional examples of sections of the interviews supporting the theme of 'Confidence grows with knowledge of bioscience'

So now I do know what I am looking at, partly because on the computer, it gives you a star if it is wrong, and it gives you the normal range, it is about finding out, which ones go together, it is actually fantastic, if they have been an inpatient, you can get their results at home, from the same lab, you can do a flow of what the alterations are, so you can get something to explain to you that since you put them on Spironalactone or whatever, you can then look at their creatinine and testing their sodium.

Yes, white cell count they have got an infection, haemoglobin, within my sort of area, although I had someone with a pituitary tumour with a massive prolactin and a drug to counteract that, bromocriptine and I did feel confident to ring up and say, we've done this, this and this, what shall we do with him now?

Yes, you become more trusted as a team member because they know you know what you are doing and why you are doing it. It probably didn't change my relationships with the house officers because they were as newly qualified as I was and probably as much in the dark but with people like the SHO and the registrar and where there are long term appointments rather than the regular turn over of house officers and certainly in dealing with the consultants I felt more sort of instead of 'yes sir I'll take all your instructions' I'd say 'why?' And it wasn't 'why?' as a challenge it was 'why?' as 'I don't understand', and sometimes it was 'why?' as a challenge and sometimes it was 'why, I don't understand, I don't see the link?' but I felt more comfortable with saying 'why?' not greenhorn in terms of I know nothing but as I understand this and that but 'why I don't see the link'

No I probably wouldn't have done (before the course) or I wouldn't have felt as comfortable or I might have gone off and said to somebody 'tell me am I right in saying this or that'. Afterwards I felt more confident about my own knowledge base,

---

And trying to refer to ophthalmology, but because you could talk the talk having worked in an ophthalmic ward, I could say, I could use terms that he knew that I knew what I was talking about and I very seldom had problems referring patients with ophthalmic problems.

The main findings have been analysed in this chapter under the emerging themes. The following chapter further explores the findings by referring to the research questions, by looking back at the main themes from the literature, and by providing a critique of the research methods used in this study.

5. Key messages and emerging knowledge

An analysis of the results has been provided in the previous chapter. Further exploration and analysis of the findings is now undertaken by revisiting the original research questions. This provides the opportunity to synthesise the analysis with the main issues emerging from the literature review. These strategies are utilised to clarify the key messages in relation to the emerging new knowledge. The chapter also provides the opportunity to examine the research methods used, particularly to provide a critique of the trustworthiness of the research.

The research questions being explored are, for nurses starting a Nurse Prescriber programme:

1. What is the perceived breadth and depth of the bioscience knowledge held by nurses in relation to their practice, and how confident are these nurses in their knowledge?
2. How have nurses gained their knowledge of biological sciences?
3. What is the perceived relative impact of formal and informal methods of learning on acquisition of bioscience knowledge?

Breadth, depth and confidence in bioscience knowledge

For this group of Nurse Prescribers, the bioscience knowledge gained through pre-registration programmes was perceived to be insufficient and did not adequately prepare them for their role as a registered nurse. The majority of respondents indicated that bioscience content was limited in their pre-registration programme, lacking depth, detail and applicability to role. This finding concurs with the existing research literature (Clarke, 1995; Wynne et al, 1997; Clancy et al, 2000; Friedel and Treagust, 2005). The findings of the current study also support the existing literature in that students express a greater need for bioscience to prepare them to be registered nurses than the pre-registration programme actually includes (Clancy et al, 2000; Friedel and Treagust, 2005). Despite the fact that the bioscience teaching in pre-registration programmes undertaken by the participants in the current study was often or usually linked to the practice setting, there had been insufficient bioscience in these programmes and interviews indicated that the links to

practice were not at an appropriate level. Wynne et al (1997) summarise the changes to pre-registration nursing programmes and the reduction in bioscience that had occurred from the 1970s to the 1990s. Jordan et al (2000) and Trnobranski (1993) also argue that reduction in bioscience has occurred. This finding that pre-registration bioscience is insufficient is therefore not a new one, and it is not solely a UK problem, Friedel and Treagust (2005) identified a similar situation in New Zealand where 81% of students stated they wanted more bioscience in the pre-registration curriculum. Friedel and Treagust (2005) also suggested links between bioscience in pre-registration programmes and the nurses' roles, proposing that doctors and patients probably expect nurses to have greater understanding of procedures and disease than they actually possess. It is of great concern, though, that no changes appear to have been effective in improving the situation since Wilson first identified a problem with lack of sufficient preparation for registration in 1975. All interviewees in the current study indicated a lack of preparedness for role as a result of their pre-registration programme; questionnaire analysis did not give such a strong sense of lack of preparation for role, although there was a large number (40.5% of respondents) not prepared for the role of the registered nurse in the knowledge of bioscience. There is a significant message here. The research participants in this study have articulated their needs in relation to the pre-registration curriculum. The users of the curriculum are quite clear that it does not meet user need – the pre-registration learning of bioscience does not match the learning the nurses need to carry out their role on qualification.

In examining the different components of bioscience, anatomy and physiology emerge as those with the widest coverage and the strongest relevance. Anatomy and physiology coverage was better than coverage of microbiology, pharmacology or biochemistry although nurses considered all five aspects of bioscience to be relevant to their role. On starting the Nurse Prescriber programme, registered nurses had more confidence in their knowledge of anatomy and physiology than they did in their knowledge of microbiology, pharmacology or biochemistry. Nurses in this study working in hospital and GP Practice settings needed more knowledge of anatomy than did their

counterparts in community settings. Nurses in GP Practice settings had greater confidence in their knowledge of anatomy than their counterparts in hospital or other community settings. All nurses, whatever their work setting, needed a lot of knowledge of physiology and pharmacology. The finding of very limited coverage of pharmacology is important and significant in a time when a large number of medications are prescribed and the administration of drugs and monitoring of effects is the role of the nurse. It suggests that nurses may be acting through routine or habit rather than as knowledgeable practitioners. Nurses from all work settings identified a considerable need for pharmacological knowledge, this presumably related to the new role of Nurse Prescriber and recognised the lack of pharmacological knowledge of the nurses on entry to the Nurse Prescriber programme.

The finding of limited coverage of microbiology may be worth further exploration through research as this could potentially be a factor in lack of success of infection control procedures. There is little literature about the different components of bioscience in the pre-registration programme, so many of these findings are new. Courteney (1991) did identify the need for anatomical knowledge expressed by nursing students, Morrison-Griffiths et al (2002) identified the varying and insufficient inclusion of pharmacology in pre-registration programmes, and Bradley et al (2006) identified the need for a range of biosciences in the Nurse Prescriber programme. However, there does not appear to be any studies of the exact requirements nurses have for anatomy, physiology, microbiology, pharmacology or biochemistry since Wilson's (1975) extensive piece of observational work and Eraut et al's study of general nurses (1995). Those nurses qualifying most recently (since 1995), and/or with fewer than 5 years experience, reported even more limited coverage of bioscience in their pre-registration programme. This is of concern as it suggests the situation is worsening as a result of changes that have occurred in the pre-registration curriculum rather than improving. Some recent work has emerged relating to the pharmacological knowledge in use by nurses (Courteney, 2002; Bradley et al, 2006) but the current study has demonstrated the need for a far greater understanding of the relationship between bioscience knowledge and specific practice settings.

Data analysis of the relevance of different aspects of bioscience to job role seems to strongly suggest the need to tailor the pre-registration programme to the role on qualification, through some level of differentiation to meet specific needs of different roles. This concept of differentiation in the pre-registration curriculum could, arguably, be said to already exist in the provision of a Common Foundation Programme in nursing followed by more tailored Branch programmes. However, the findings from this study indicate that this is far from sufficient. Nurses entering the profession may enter a role as a staff nurse in a community setting visiting people in their own homes, on an intensive care unit, in an outpatients department, a general ward or an emergency admissions unit, to give a few examples. These roles have different requirements for bioscience knowledge, but this is not currently taken account of in the pre-registration nursing curriculum. This study clearly identifies a lack of congruence between what is taught and what is required. There is a demand for more bioscience in pre-registration nursing programmes and greater differentiation by intended role. The question now is, does the pre-registration programme have the potential to reflect this? Increased bioscience is possible through a more patient-centred and scenario based presentation of material. The behavioural sciences are also likely to benefit from this approach, making the learning of sociology or psychology more firmly grounded in their application to practice. If nurse specialists were used as expert teachers, their holistic knowledge could benefit the student's ability to apply science to the practice setting. Differentiation by intended role would require an earlier identification of that role, instead of the present situation where jobs are not known until after registration. If final year clinical placements were to reflect the intended role, the potential for differentiation would be increased.

Bioscience knowledge increased through experiences in the workplace and through discussion with colleagues. Confidence in bioscience knowledge grew through work experiences but was not improved markedly until formal education in post-registration programmes occurred. The pre-registration programme did not engender confidence in knowledge. This indicates an

emphasis on development of competence in the curriculum divorced from the acquisition of knowledge, understanding or experience of clinical scenarios to enable confident practice on initial registration as a nurse. The pre-registration curriculum has a job to do in producing more than competent practitioners, it needs to produce competent and confident professionals (NMC, 2004; Watson, 2006).

The variation in knowledge of bioscience at the start of pre-registration nursing programmes was identified as a theme in the original literature review (Wynne et al, 1997; Courteney, 2002; Clancy et al, 2000). This theme has not been explored in the current study except in the gathering of information in the questionnaire about whether students had GCSE or A level bioscience qualifications or had already studied for a science degree. 38 out of the 42 participants had a pass at 'O' level or GCSE in biology or science, and 13 had passes at 'A' level biology. Clearly the students did have varied bioscience knowledge on entry to initial nursing programmes. It would be interesting to study whether those nurses entering Nurse Prescriber programmes were more likely to have these qualifications than registered nurses in general.

The literature review identified that nurses had varying levels of bioscience knowledge on qualifying as a nurse (Wharrad et al, 1994; Clancy et al, 2000). This theme was not specifically explored in the current study although variation can be deduced from the questionnaire results. For example, from Figure 4.2a there was a wide range of responses to the question 'how extensive was the bioscience content of your pre-registration course' with 33.3% (14 participants) indicating content was adequate, 57.1% (24 participants) indicating it was limited, and 9.5% (4 participants indicating extensive coverage). Participants were not asked to identify the institution where their pre-registration nursing programme had taken place. This could have been useful in giving a view of the number of different nursing programmes participants were responding in relation to and also could have been used for comparison if more than one participant had undertaken the same programme at the same educational institution.

Becoming knowledgeable in bioscience

Nurses in this study explained that they had gained knowledge of bioscience in many ways. Nurses had gained knowledge of bioscience through pre-registration programmes, even though this had been insufficient. The existing literature demonstrates a concern with the lack of bioscience knowledge of the nurse lecturer (Courteney, 1991, 2002; Clarke, 1995; Clancy et al, 2000). This theme was not explored in the current study although there was some evidence from the interviews that examples used in the teaching of bioscience were irrelevant or outdated:

'unfortunately the tutor we had there wasn't very good and was very out of date with current practice and although she was teaching us about the biosciences, she would pepper it with anecdotes about work which were set in a different time'

Other evidence suggested too much behavioural science in the curriculum:

'the Diploma I did was very airy fairy wishy-washy it was lots of sociology psychology that sort of stuff not a biologically based diploma'

This finding reinforces the work of Wynne et al (1997) and Jordan et al (2000), acknowledging the competing discourses of biological and behavioural sciences. These authors described the expansion of behavioural sciences in the curriculum from the introduction of Project 2000, and its negative effect on bioscience in the curriculum, reducing the bioscience content. A sense that nurse lecturers are more comfortable teaching the behavioural sciences applied to nursing than they are teaching the biosciences applied to nursing, and the lack of holism this creates, is a strong message from previous studies (Friedel and Treagust, 2005; Jordan et al, 2000; Wynne et al, 1997; Clarke, 1995; Courteney, 1991).

Nurses participating in the current study had learned new knowledge of bioscience, and had begun to apply existing knowledge, in the workplace. This was through experience of different diseases and treatments and through discussion with colleagues. Bioscience content of post-registration programmes had been useful, and was necessary in developing confidence related to nursing practice. Using the knowledge from post-registration programmes in a work setting enabled the nurse to become confident in that

knowledge. Both questionnaires and interviews indicated that the most effective way of learning bioscience was to embed the learning in practice, and to learn disease processes and applied biology rather than superficial anatomy or physiology. Interview findings for the importance of knowledge being linked to practice are particularly strong. The significance of the theory to practice gap in limiting learning was emphasised, and the importance of involving the student in reflecting on and discussing their knowledge was highlighted. These findings are not new; in fact they have been demonstrated extensively in the literature. For example, Courteney (1991) found that students learned more bioscience in the clinical area than from the classroom, Gresty and Cotton (2003) summarised the lack of application of bioscience knowledge to practice in explaining the development of on line learning for bioscience, and Clancy et al (2000) showed that the bioscience content of pre-registration programmes to underpin practice was lacking. That is, Clancy et al (2000) identified the mismatch between what was needed in the clinical area and what was available in the classroom. The findings in the current study confirm that nurses learn bioscience knowledge from their experiences at work and that these experiences are more significant than classroom teaching in the development of knowledge. Literature on adult learning theory (Knowles, 1996, 2005) and literature concerning professional learning (Eraut, 1997; Quinn, 2000; Prowse and Heath, 2004) suggest that adult students of nursing will learn best by reference to the real world of clinical practice and through a mixture of facilitated learning methods such as reflection, relating learning to their previous experience, and discussion (Knowles, 2005). The message here is that pre-registration nurse education should be more firmly embedded in the real world of clinical practice and more student-centred than is the case described by the Nurse Prescribers in this study.

The interview findings indicate that learning from colleagues, particularly medical staff, was very important in the understanding of bioscience. This appears to be a new finding and may be worth further exploration. This finding may apply mainly to the Nurse Prescribers in their new roles. That is, with a move back to the medical model of practice that Nurse Prescribing

requires (Bradley et al, 2006) there is also a need by the Nurse Prescribers for the greater bioscience knowledge traditionally held by doctors. Latter et al (2007) note the role doctors are expected to play in supervision of Nurse Prescribers. However the findings from the interviews in this study suggest that learning bioscience knowledge from medical staff is important in roles other than Nurse Prescriber and at points throughout the nursing career.

Formal and informal methods of learning

Formal methods of learning in the pre-registration programme appear to be relatively weak at achieving adequate bioscience knowledge in the newly registered nurse. Even where bioscience content was present in the pre-registration curriculum, and linked to practice, it was insufficient and did not give enough depth. These findings are discussed above. In particular, insufficient attention was paid to microbiology, pharmacology and biochemistry. The results suggest that teaching on pre-registration programmes did help the learning of bioscience, but that it did not help enough to enable the participants to undertake their roles as registered nurses. Post registration courses that include bioscience support knowledge development and also give confidence in use of the knowledge in the work setting. The results from both questionnaire and interviews indicate that formal learning has an important role to play in helping develop knowledge of bioscience, and that bioscience knowledge in post-registration programmes is more useful than that in pre-registration programmes. The post-registration programmes appear to include bioscience that is more directly related to the current role of the nurse, hence making greater use of adult learning theory which recommends that new knowledge is best learned in relation to the student's current and previous experience (Knowles, 2005). The development of confidence that occurs following learning of bioscience in post-registration programmes is demonstrated in a wider setting in the current study than that demonstrated so far in the literature. Jordan and Reid (1997) have described similar findings in relation to a single post-registration programme as part of an action research study.

Informal learning in practice through experience and through discussion with colleagues, and through self-directed reading, was demonstrated as being very important in helping the learning of bioscience and had a stronger role to play than formal learning. Some aspects of these findings are new. For example, the relative importance of formal and informal learning has not been reported in previous studies and the importance of learning bioscience from medical staff is new. The role of informal learning is not apparent in the research literature and could be investigated here in relation to bioscience learning. Informal learning appears to be important in confidence building in relation to the knowledge needed and application to the work setting. This area needs further exploration.

The significance afforded to informal learning by participants in this study is a key message. Informal learning has been shown to be powerful but is not evident in the teaching and learning strategy of current pre-registration curricula. The mechanisms of informal learning emerging in the educational literature (Eraut, 2004; Hoekstra et al, 2007) need to be taken account of and used to impact upon the pedagogical approach to formal education at both pre-registration and post-registration level. Research to develop greater understanding of informal learning by nurses should be undertaken in order to act on this finding. Finding out more about what people learn informally, how effective that learning is, and how it can be more consistently reflected and given relevance at the level of formal training is required.

Critique of research methods used

In criticism of the sampling used for this study, using the students on the Nurse Prescriber programme, while in one sense being purposive in deliberately selecting certain individuals it could be argued that this was simply a convenience sample based on a population of nurses being easily accessible to the researcher (Saks and Allsop, 2007). Some researchers would criticise this for being a very rudimentary approach. However, for the purposes of a case study, using a defined population as the case, convenience sampling is recommended provided the case is described in sufficient detail (Punch, 2005) and the selection of particular cases is

recommended by Huberman and Miles (2002) providing there is a clear explanation of why the sample has been chosen.

The range of job roles of the students in the Nurse Prescriber programme is important. There is equal representation from those nurses working from a hospital base and those working outside the hospital in community and GP practice settings. However results have been shown in three categories, with the non-hospital group split between general community and GP Practice. When the Nurse Prescriber programme was first implemented, it was mainly community nurses who undertook this programme and this may need to be considered if findings are to be applied to other groups (Bradley et al, 2006).

The purposive sampling used to recruit for interviews for this study is not the same as convenience sampling. Saks and Allsop (2007) explain that purposive sampling is the selection of individuals for inclusion based on criteria to increase the sample's representation of the case being explored. This technique is widely used in qualitative research (Sim and Wright, 2000). The randomisation of selection of participants that is a feature of studies using a positivist paradigm aims to reduce bias. The current study does not fit into the positivist paradigm, being interpretive, exploratory and qualitative, and randomisation of participants has not occurred (Saks and Allsop, 2007). The use of self-selection of participants as a means of identifying those who could be interviewed is, however, open to criticism. It could be argued that those presenting themselves as willing to be interviewed are not representative of the wider group or have a particular interest in the topic and may therefore bias the results. The use of the initial questionnaire enabled the researcher to identify features of the whole group of nurse prescribers. Careful attention was paid to ensuring that, despite self-selecting as willing to be interviewed, the interviewees did in fact represent the main features of the whole group of participants (see job roles and specialisms in Appendices B and C). In addition, purposive sampling to ensure all features of the group were represented, and checking emerging themes with other interviewees, was undertaken to ensure as far as possible that there was no bias in favour of the self-selected interviewees.

All questionnaires are subject to criticism but are very widely used in research (Saks and Allsop, 2007). It is good practice to test questions before use, and this was done in the current study. The questions were critically reflected upon by the researcher, to ensure they appeared to be asking what was intended, before being incorporated into the final questionnaire. Several of the advantages in using self-completed questionnaires identified by Sim and Wright (2000) were evident in the questionnaire used in the current study. For example: it was easy to guarantee confidentiality of respondents; the language used was the same for all participants; the tool was easy to use; responses enabled simple descriptive statistics to be applied; and the researcher did not have direct contact during completion of the questionnaire.

The disadvantages of self-completed questionnaires (Sim and Wright, 2000) were also evident in the current study. These include a lack of exploration of issues and limited available responses – this was addressed in the current study by using interviews with some participants in addition to questionnaires. A further disadvantage is that some questions may not be answered and it is usually not possible to identify why this is the case, in the current study those questionnaires that were incomplete were not included in the study. This in itself may have led to the exclusion of some relevant data. It has been identified earlier that some participants may have been sent on the Nurse Prescriber programme by their manager, and may have been participating in the programme under duress, this could have led to entering untrue information in the questionnaire. However, this is unlikely to have occurred in this study, as if such individuals were present in the Nurse Prescriber programme, they would be unlikely to consent to participate in the survey. There is the potential for bias either in different interpretations of the questions or in the lack of understanding of the questions. Every effort was made to avoid this bias, firstly in the construction of the questions and the researcher's own critical reflection on their suitability, and secondly by the use of a trial of the questions before the final questionnaire was developed.

A further criticism of the questionnaire is the use of adverbial/adjectival rating scales to measure grades of response. A Likert scale could have been used. The Likert scale is a 'method of summated ratings' (Punch, 2005, p91) and is used extensively to measure attitude and is 'widely used in social research' (Punch, 2005, p91). The numbers and letters in items 6 and 12 of the questionnaire (see Appendix One) were used solely for ease of completion of the items by the respondent, they were not used to calculate mean values of responses as this would have not been an accurate reflection of the situation, the numbers and letters in the items represent statements rather than numerical values. Likert scales are generally used to measure agreement or disagreement with a statement over a four or five point scale, this was not the structure of the responses in this study. The scale used does not give value to the response even though numerical values are applied. Likert scales have been praised for their simplicity but criticised for lack of ability to clearly distinguish between categories (Punch, 2005).

It was decided not to use a true numerical scale for the current study, as it would not be possible to give a numerical value to distinguish between categories of response, for example using a numerical value of 1 to 'limited', 2 to 'adequate' and 3 to 'extensive' would have suggested that the value of 2 was twice as much as 1, but the difference between 'limited' and 'adequate' cannot in fact be interpreted in this way. The adverbial/adjectival scale was chosen as more appropriate to the purpose of the study. Adverbial/adjectival responses were graded so that the relationship between each response was clear, this is recommended by Sim and Wright (2000). Respondents chose a response, and the percentage of respondents in each category was determined, but the responses themselves were not analysed from their numerical value. The use of a Thurstone scale is recommended by Sim and Wright (2000) and by Punch (2005). Construction of such a dichotomous scale could have given greater selectivity to the responses and could have distinguished more clearly between respondents. This could be an appropriate scale to use for further investigation in this area.

Semi-structured interviews were used as an additional method of data collection in this study. The researcher had undergone a training course in interviewing for research purposes and this course had identified some of the difficulties that may occur during interviews. The researcher had also undertaken other interviews and was not therefore a novice interviewer but neither did the researcher have extensive experience of interviewing and this could be considered a criticism of the research. Carter and Henderson (2005) advise against the use of leading questions. The interviewer was careful to avoid deliberately leading the interviewees to desired answers and used open style questions such as 'tell me about your experience of learning biosciences during your pre-registration programme' rather than leading questions such as 'would you say there was insufficient bioscience in your pre-registration programme'. This use of open questions enabled the interviewee to tell their own story, without a sense that they may not be telling the interviewer something they did not want to know.

A further criticism of the researcher conducting the interview is that the researcher was familiar with a range of clinical areas and understood most of the terminology used by the interviewees. There was a considerable possibility that the familiarity of the researcher with the subject material could lead to assumptions being made about what the interviewees were saying. The interviewer had to take deliberate steps to consciously avoid making assumptions, as advised by Carter and Henderson (2005) – this conscious effort occurred during the interviews, with reflection by the interviewer occurring after each interview to see if any aspect of the interview could have been construed as leading or making assumptions. The advantage of the interviewer being familiar with a range of clinical areas and terminology meant that the interviewee did not have to spend time explaining conditions or tests which were mentioned to enable the interviewer to gain understanding, but rather it gave the interviewer enough knowledge to be able to question the interviewee more extensively to gain a fuller picture of their story.

The analysis of data was carried out methodically and systematically. Nevertheless, it is possible that bias was introduced at this stage. For

example, the categories chosen for year of qualification were based on changes in pre-registration programmes relevant to the year groups, but may not fully represent the picture. It was not possible with a cohort of 42 respondents to examine the data for correlation between actual year of qualification and bioscience knowledge. Similarly, the division of job roles into hospital based, GP Practice based and other community based roles could have been carried out with different categories or different subgroups, for example including community matrons, community mental health workers, community staff nurses as separate grouping for community based roles. Or the nurse specialists across hospital and community areas could have formed a separate category. Further work should be carried out before drawing generalisable conclusions based on job role groups.

Within the analysis, there was no differentiation of participants by the pre-registration programme that the participants had undertaken. While the NMC does give broad guidance on the curriculum, it does not give specific guidance and hence there may have been considerable variety in the depth and breadth of the pre-registration experiences of the participants and these programmes would have been undertaken at numerous different establishments. The analysis does not link findings to particular pre-registration programmes.

6. Conclusions and recommendations

To examine the bioscience knowledge of registered nurses undertaking a Nurse Prescriber programme, this case study has used both quantitative and qualitative methods to explore the level of bioscience knowledge held in relation to role, the confidence with which the bioscience knowledge is held and the relative impact of formal and informal methods of learning biosciences. Initially, a questionnaire was used to survey the views of 42 registered nurses from a variety of clinical settings. Following this, interviews were carried out with a small number of students on the Nurse Prescriber programme. The results from the questionnaire were analysed using the SPSS computer software package and the results from transcribed interviews were coded manually. This chapter draws on the findings and key messages described in chapters 4 and 5 and makes final conclusions and recommendations.

Conclusions

The perceived breadth and depth of the bioscience knowledge held by nurses in this study in relation to their practice was insufficient for them to carry out their role when they first registered as nurses, this was particularly the case for knowledge of pharmacology, microbiology and biochemistry. The participants demonstrated a greater need for bioscience than the pre-registration nursing curriculum had prepared them for. The participants did not indicate that pre-registration nursing had been of no use, but that it had not been sufficient in terms of the coverage of topics or the detail of those topics. Furthermore, the pre-registration programmes had not enabled the participants to apply their learning sufficiently to the clinical setting. The finding of insufficient bioscience content in pre-registration programmes is not new, it supports other research findings over a considerable time period (Clarke, 1995; Wynne et al, 1997; Clancy et al, 2000; Friedel and Treagust, 2005). What is new is that the current study suggests that the inadequate bioscience content of pre-registration programmes is having a negative impact on the ability to function in the role of registered nurse. This finding of lack of preparedness for role was particularly strong from the interviews. The deduction from this finding is that newly qualified nurses are being asked

to undertake roles for which they have not had sufficient theoretical preparation.

A further concern from this study is that the most recently qualified registered nurses expressed greatest dissatisfaction with the bioscience content of their pre-registration programmes. This is assumed to be due to the changes documented in the research literature that demonstrates a reduction in bioscience content in pre-registration programmes since the early 1990s. It could also be linked to developments in the roles nurses are undertaking as they register, for example there may be an increase in use of technology and there has been a change in the severity of illness of hospitalised patients, with earlier discharge meaning more beds are occupied by severely ill patients and community nurses are also dealing with patients who are more severely ill than in the past (Hinchliff et al, 2003). In either case, there is concern that the student of nursing is not sufficiently prepared in bioscience to undertake the role of the registered nurse. In fact there does not appear to have been a link between developments in the NHS and developments in the pre-registration nursing curriculum, that is many of the new roles undertaken by nurses are not reflected in pre-registration programmes.

The current consultation on changes required for pre-registration nursing programmes (NMC, 2007) should examine the link between the newly registered nurse's work role and the pre-registration nursing programme. The consultation does include aspects of learning in practice, but this relates to hours in practice rather than the way in which this may be structured to promote learning. The focus of the consultation does not appear to seek information about how well current programmes prepare for role, rather it seeks to change the structure of the programme to ensure EEC directives are met and the structure mirrors future Department of Health structures for the delivery of health care services. Whilst this latter idea is likely to be useful, it will not be so unless there is significant work to demonstrate the knowledge and skills a registered nurse needs on entry to the profession. The NHS has endeavoured to identify specific knowledge and skills needed in relation to role development following registration (DoH, 2004) but this has been based

on a competency framework and limits the element of knowledge and understanding in relation to role. The roles of nurses in particular settings are described in relation to tasks they are competent to undertake, ignoring the higher level critical skills that nurses undertake in their clinical practice. The focus of change to nurse education has been the post-registration programmes. These have been and continue to be developed in line with the Department of Health's programme for Modernising Nursing Careers (DoH, 2006 and 2007a). The opportunity to better prepare students of nursing for registration has not been addressed in this work. The current study suggests students could achieve more from their pre-registration programme if changes were made.

The new findings in this study relating to bioscience in pre-registration nursing link a lack of bioscience to an inability to undertake the role of a registered nurse. The students appear willing to learn more, and see the importance of learning more bioscience, but the curriculum does not offer this additional content.

However, despite the insufficient initial preparation in biosciences for the role of registered nurse, knowledge of biosciences had grown for the participants in this study through experiences in the workplace, discussion with colleagues, self-study, and formal post-registration study. Links between formal and informal learning are not apparent – there appears to be a division between what is learned formally on a particular programme of study, and what is learned informally in relation to the job being undertaken. Respondents indicated that a lot of bioscience knowledge was needed to undertake the role of the nurse, including anatomy, physiology and pharmacology as well as, although to a lesser extent, microbiology and biochemistry. There was some variation in breadth and depth of knowledge needed by job role. Those in GP practice settings and hospital settings indicated a greater need for knowledge of anatomy than those based in community settings (Figure 4.2d). This should be explored further. It may be that community nurses deal with a narrower range of illnesses than those in GP practices and hospital settings, or it may be that the role of the community

nurse differs in other ways in the use of bioscience, for example there may be less invasive techniques used by community nurses compared to nurses in GP and hospital settings.

Nurses in hospital settings expressed greater confidence in their knowledge of anatomy and physiology in relation to their current role than did nurses in GP practice settings; the least confident were nurses in community settings. This may relate to a greater disease focus of hospital roles when compared to GP practice or community based roles or this finding may link to the finding on learning from medical staff. That is, the hospital-based nurses may have greater opportunity to learn from medical staff. A further possibility is that the nurses in hospital settings may have been more likely to attend post-registration programmes containing relevant anatomy and physiology than the nurses based in GP practices or the community. Across all job roles, at the start of the Nurse Prescriber programme and in relation to current role, confidence in anatomy and physiology was greater than confidence in microbiology, pharmacology or biochemistry. This matches the findings for coverage of these topics in pre-registration programmes. At the start of the Nurse Prescriber programme, the nurses from community settings appeared most confident in their pharmacology knowledge and least confident in biochemistry knowledge, while those from hospital setting were least confident in pharmacology knowledge. However, when questioned in relation to current role, the levels of confidence across all three groups did not indicate a substantial difference by job role. Some new findings are emerging from this study. The varied bioscience knowledge needed in relation to the variety of roles nurses undertake appears to be important, but the numbers of participants in this study from the different groups of roles means that generalisations cannot yet be made. The use of different aspects of bioscience knowledge by different nurses in different settings is worth further exploration.

Learning of biosciences had mainly taken place in the practice setting, relating theory to practice in the classroom had not been sufficient to embed learning in practice. This is an important finding for the nurses in this study

because it suggests the pre-registration bioscience teaching in the classroom should be largely replaced with teaching in the clinical setting. Learning biosciences in the practice setting as part of the formal means of teaching bioscience has long been part of the education to become a medical practitioner (Norman et al, 2002). This may be because medical lecturers during the clinical years of medical education do not remove themselves geographically from the practice setting to reside in a University campus in the same way that nursing lecturers do. Rather, the medical lecturers in clinical years are the physicians, surgeons and other specialists who have a caseload of patients/clients in the clinical setting and use these patients/clients in their teaching. The medical education programme may have much to teach nursing education here. Use of experts to deliver teaching in the clinical area in relation to real patients/clients and clinical settings would appear to be what is missing from the pre-registration programme in bioscience education.

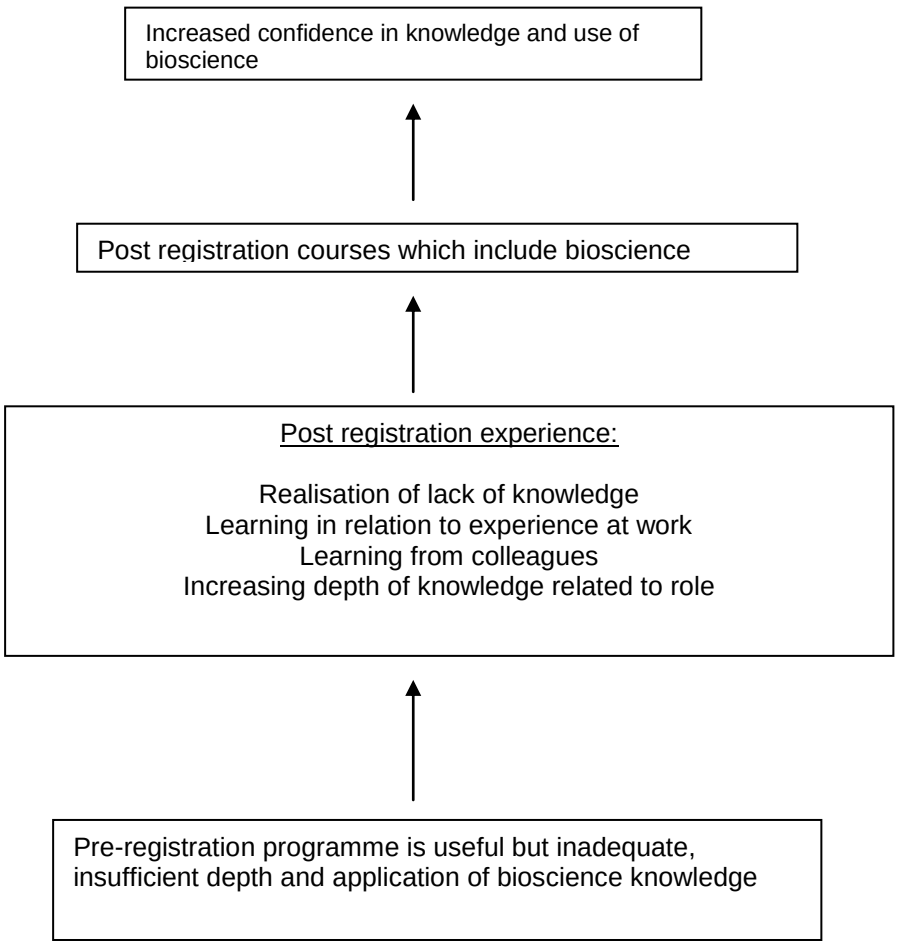
Although the depth and breadth of bioscience knowledge of nurses in this study had increased mainly as a result of clinical experience, confidence in bioscience knowledge had grown as a result of post-registration programmes, both University based and work-based. Post –registration programmes of learning based in the workplace or the University were valuable in learning of bioscience. The current study extends the findings of Jordan and Reid (1996), which looked at the effect of one post-registration programme, to the importance of all post-registration programmes in learning of biosciences related to practice. The findings from the current study are not only broader but also more detailed in the relevance and application of knowledge in the work setting. A specific finding from the current study is the increased esteem in which medical staff were held, not in the sense of superiority of role, but in terms of confidence with knowledge that was desirable to the nurses. The current study also confirmed the increased confidence in communication with medical staff that had been found by Jordan and Reid (1996). Findings about how nurses learn bioscience are as much about the teaching as the learning. The significant role of experience of diseases and treatments in the workplace is much stronger from the current study than from

previous studies. The nurses in the current study did not indicate that the pre-registration content had been of no use, or even set wholly apart from practice, but did indicate that it was insufficiently grounded in the reality of patients being nursed for the nurses to transfer their learning to the practice setting. The importance of informal learning and learning through experience of real patients' conditions emerged very strongly in the current research. The support of knowledgeable colleagues, and particularly medical colleagues, in learning bioscience, is a new finding.

In summary, key findings from this study include the lack of preparedness for role at the point of registration as a nurse. This finding includes the inadequacy of bioscience learning from pre-registration nursing programmes, the importance of embedding learning into practice and the importance of the practice setting as the place of bioscience learning. The range of bioscience topics that nurses see to be relevant to their role is greater than the knowledge held in these topics. In addition there is evidence of a willingness and desire to learn bioscience from medical staff and a sense that there is improved communication with medical team as a result of improved knowledge. Greater breadth and depth of coverage of anatomy, physiology, microbiology, pharmacology and biochemistry was considered by the participants in this study to be necessary in pre-registration programmes because of their relevance to the role of the registered nurse. The findings here support the findings of Morrison-Griffiths et al (2002) and Danielson and Berntsson's (2007) and lend strength to the argument for increased bioscience in pre-registration nursing programmes.

Overall the findings from this study suggest a model of learning currently in use for bioscience in nursing as shown in Figure 6.1.

Figure 6.1 – Current model for learning of bioscience in nursing



Generalisability of findings

This research has been a case study of Nurse Prescribers. The extent to which the findings from this study are generalisable to other experienced nurses or those nurses undertaking Nurse Prescriber programmes is an area for discussion and further research. The fuzzy generalisations and fuzzy predictions developed are based clearly in the evidence and related to other literature concerned with the theme of this research as recommended by Bassey (1999).

The first generalisation proposed is that bioscience in pre-registration nursing education that is embedded in the real world of clinical practice and is learned using student centred approaches is likely to lead to greater and more relevant knowledge of bioscience in the registered nurse. Moving from a strong finding relating to the participants in this case study to a generalisation relating to all pre-registration programmes is a bold step for a qualitative study but the move is based in evidence not only from the current study but also from other research findings. Applying humanistic theories of learning would mean the inclusion of reflection on clinical incidents and clinical experiences to develop knowledge and understanding and the use of more real world experiences and less lectures or didactic teaching methods with the teacher as a facilitator of learning (Knowles, 1996; Kolb, 1984; Dart, 1997; Quinn and Hughes, 2007). The current study is able to relate these theories to the learning occurring on pre-registration programmes. Nurses in this study identified that informal learning, both from colleagues and by experience, were more important than formal methods of classroom learning. The study participants also identified the lack of preparation in bioscience that occurred in the pre-registration programme and the need to firmly embed learning in practice. The generalisation follows much of Benner's findings relating to development of expert knowledge, that is, the expert cannot develop unless the registered nurse is already a knowledgeable practitioner.

Nurse prescribers in this study identified insufficient breadth and depth of bioscience in their pre-registration programme, so that they were not prepared for role. The findings from this study and others indicate that some generalisation can be made: Nurses entering a Nurse Prescriber programme are unlikely to have sufficient bioscience knowledge to enable them to prescribe effectively, and will need considerable additional knowledge, particularly of microbiology, pharmacology and biochemistry. This generalisation is made not only from the results of the current study but also with reference to the work of Morrison-Griffiths et al (2002) who discovered varying inclusion of pharmacology in the pre-registration curriculum and perceptions by the nurses that this had been insufficient. Courteney's (1991) work and Danielson and Berntsson's (2007) study clearly support this

generalisation in relation to anatomical knowledge and the range of bioscience knowledge respectively.

Post registration programmes have been demonstrated to improve confidence in bioscience knowledge. A generalisation can be made from the findings of the current study: Following a Nurse Prescriber qualification, the nurse is likely to become more confident in his/her knowledge of bioscience relevant to his/her area of practice. This generalisation is supported by strength of responses in the current study and by the work of Jordan and Reid (1996).

In this study, the role of medical staff in promoting bioscience knowledge was identified as important and useful. The following generalisation cannot yet be made, even tentatively, but may be pursued after further research: many registered nurses are likely to have learned previously from medical staff, and are not only happy to continue to do so but also keen to make use of this expert knowledge to build their confidence. There is insufficient evidence from the questionnaire to make this a generalisation, and there is little in the literature to support this finding. However there is an emerging literature on the importance of the medical practitioner in the supervision of the Nurse Prescriber (Prowse and Heath, 2005; Latter et al, 2007).

Recommendations

This study is limited to the case of Nurse Prescribers; it is mainly qualitative and involves only a small number of subjects. Further exploration of some of the findings from this study is required to strengthen recommendations for changes to the teaching and learning of bioscience. There is clearly a need to undertake further research with students of nursing and registered nurses to determine the extent to which inadequate bioscience content of pre-registration nursing programmes affects the ability of the registered nurse to function in their role in the diverse range of settings in which they are employed. Further research regarding the bioscience knowledge needed within different nursing job roles may prove useful in assisting in curriculum development for both pre-registration and post-registration programmes

including in-service education. A lack of comparative studies by job role means that the extent of anatomical, physiological, microbiological, pharmacological or biochemical knowledge held by nurses from different settings has not been sufficiently examined.

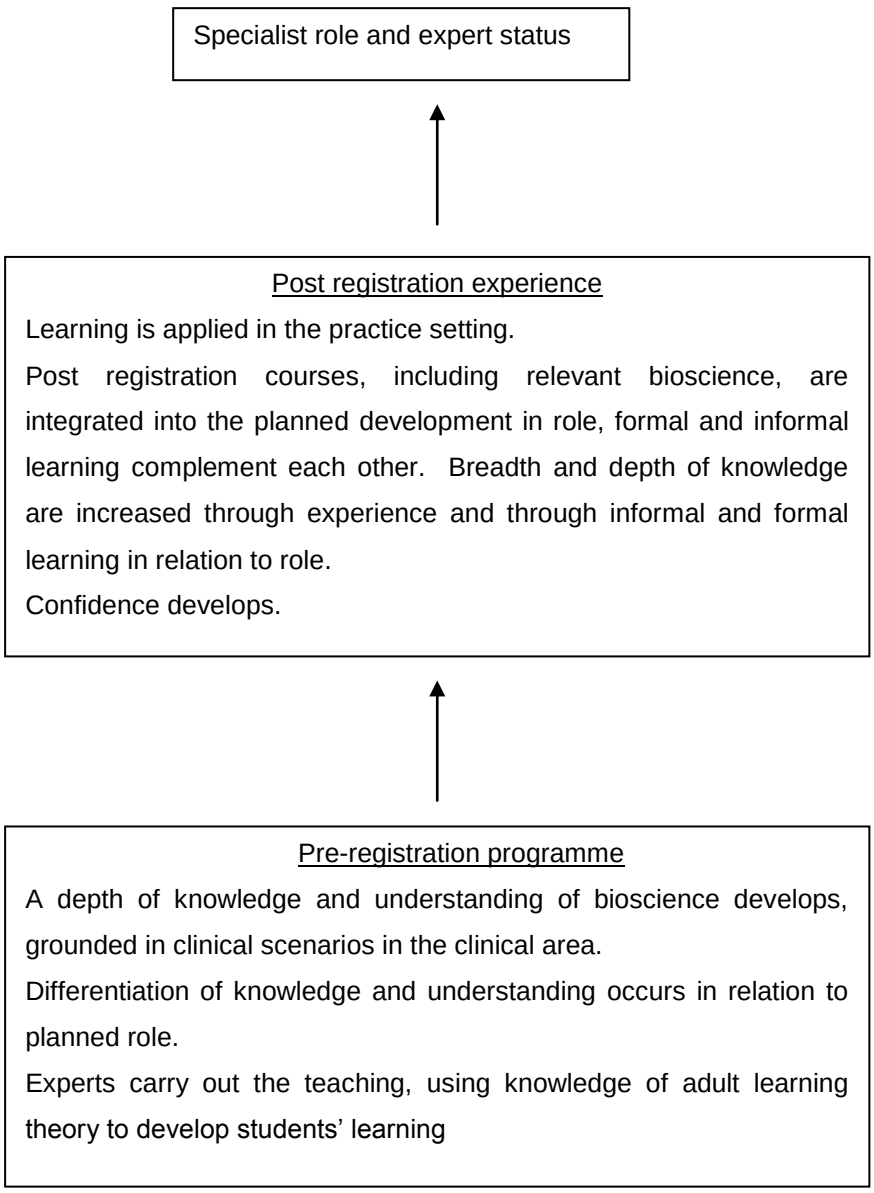
Within the constraints identified, however, a number of recommendations do arise from this study. The first, confirmed by this study and embedded strongly in previous work, is to increase the breadth and depth of bioscience content in the pre-registration nursing curriculum. Bioscience content should continue to include anatomy and physiology, but should also include pharmacology, microbiology and biochemistry related to disease processes and treatments. The recommendation to increase the overall content comes not in terms of learning by didactic methods in the classroom however, but by learning in the practice setting, in one sense taking on a more medical education model, with a real patient as the focus, but not necessarily a medical model with the disease process as the only aspect to be considered. There is the potential for learning of other aspects of the nursing curriculum to benefit by basing learning on real cases. This could increase the holism of the curriculum by balancing aspects of behavioural and biosciences through exposure to the story of real patients in their biopsychosocial context. According to this study, the need for increased and improved bioscience coverage in the pre-registration curriculum would be expected to improve preparedness for role and improve bioscience of future generations of nurses so that they can confidently pass on this knowledge. A suggested model is for small groups of nursing students, facilitated by a knowledgeable expert, to visit real patients in the clinical setting and learn bioscience in relation to the patient presentation, with signs, symptoms, and possible treatments, with a focus on the patient and how the disease is impacting on their life. The model could be adapted by an expert visiting the placement base of the student and selecting a patient (with the patient's consent) for the focus of the teaching in a similar way to the method used for education of medical students. This would clearly work more effectively with some patients than with other more vulnerable individuals such as those with unstable mental health conditions.

A further recommendation is to consider the area in which the nurse is going to work on registration, and tailor teaching of bioscience to that role. For example, those in GP practice settings and hospital settings could have greater input on anatomy and biochemistry, whereas the teaching of pharmacology could be similar in quantity but with examples related to the appropriate work setting. This could happen naturally if real cases in the area of nursing the nurse expected to work in were used in the teaching and learning of the bioscience. Further research in this area is needed before stronger recommendations can be put forward regarding the nature of a differentiated curriculum.

Greater attention needs to be given to informal learning of biosciences. Aspects of informal learning need to be incorporated into the formal approach to bioscience education. A starting point would be to place emphasis on conscious and unconscious learning as described by Hoekstra et al (2007).

A diagram of a proposed model for learning of bioscience is given in Figure 6.2.

Figure 6.2 – Proposed model for learning of bioscience in nursing



This model differs from the current practice in the following ways. At the level of pre-registration bioscience learning, the depth of knowledge and understanding would increase by embedding learning in clinical scenarios. This would not only enhance bioscience learning but also give clinical relevance to behavioural sciences and develop a greater holism for the learner. With increased progress through the curriculum, greater

differentiation would occur, embedding learning in scenarios most relevant to the intended work role.

Once registered, the model proposes that informal and formal learning are fully integrated, with the focus of both being the actual work role of the nurse. This would increase the breadth and depth of the nurses' knowledge and further improve their confidence in role. Formal learning would occur through structured, taught sessions. Informal learning would include specific action planning in relation to issues (deliberative learning), reflection-in-action (reactive learning) and learning through repetition (implicit learning) (Eraut, 2004; Hoekstra et al, 2007).

In summary, the registered nurse, whatever the role, needs bioscience knowledge. The extent of the need is not yet determined in relation to different roles. At the point of registration, this group of Nurse Prescribers did not consider themselves sufficiently prepared in biosciences to fulfil their roles – the curriculum had not sufficiently prepared them for the job they took on. This study has given the views of users of the curriculum and consequently presents a powerful argument. The nurses in this study learned far more through informal methods than they did through formal curriculum delivery. The importance of learning in the workplace and through colleagues cannot be overstated. Informal learning is not currently acknowledged in the pedagogical approaches used in nursing education. The curriculum has a job to do in producing registered practitioners who are more than competent: practitioners also need to be confident in the various and changing work settings in which they practice.

References:

American Association of Colleges of Nursing (2004) Accelerated baccalaureate and masters programs in nursing. *www.aacn.nche.edu* accessed 10.7.07.

Armitage, A., Bryant, R., Dunnill, R., Hayes, D., Hudson, A., Kent, J., Lawes, S. and Renwick, M. (2003) *Teaching and training in post-compulsory education* (2nd ed). Buckingham: Open University Press.

Ash, C. (2006) Professional issues and implications for practice. In J.E.Schober and C. Ash (Eds) *Student nurses guide to professional practice and development*. London: Hodder Education, pp11-21.

Bahn, D. (2007) Reasons for post registration learning: Impact of the learning experience. *Nurse Education Today*, **27**: 715 – 722.

Ball, J. and Pike G. (2005) *Managing to work differently – RCN employment survey.* London: Royal College of Nursing

Basit, T.N. (2003) Manual or electronic? The role of coding in qualitative data analysis. *Educational Research*, **45** (2) 143 – 154.

Bassey, M. (1999) *Case study research in educational settings*. Buckingham: Open University Press.

Bassey, M. (2001a) The concept of fuzzy generalisation. In *BERA Symposium at AERA 2001 at Seattle*. Southwell: British Educational Research Association.

Bassey, M. (2001b) A solution to the problem of generalisation in educational research: fuzzy prediction. *Oxford Review of Education*, **27** (1) 5 – 22.

Bell, J. (2005) *Doing your research project* (5th Ed). Maidenhead: Open University Press.

Benner, P. (1984) *From novice to expert*, *excellence and power in clinical nursing practice*. London: Addison Wesley.

Benner, P. (2001) *From novice to expert: excellence and power in clinical nursing practice*. London: Prentice Hall.

Benoliel, J.Q. (1996) Grounded theory and nursing knowledge, *Qualitative Health Research*, **6** (3): 406 – 428.

Boud, D., Keogh, R. and Walker, D. (1996) Promoting reflection in learning: a model. In R. Edwards, A. Hanson and H.P. Ragga, (Eds) *Boundaries of Adult Learning.* London: Routledge, pp32-56.

Bowling, A. (2002) *Research methods in health* (2nd ed). Buckingham: Open University Press.

Bradley, E., Blackshaw, C. and Nolan, P. (2006) Nurse lecturers' observations on aspects of nurse prescribing training. *Nurse Education Today*, **26**: 538 - 544

British Educational Research Association (2004), Ethical guidelines for educational research'. *www.bera.ac.uk/publications/guides/php*, accessed 16.06.07

Burns, N. and Grove, S.K. (2001) *The practice of nursing research* (4th ed). London: W.B. Saunders.

Burton, H. and Stewart, A. (2003) From Mendel to the Human Genome Project: the implications for nurse education. *Nurse Education Today*, **23**: 380 – 385.

Carter, S. and Henderson, L. (2005) Approaches to qualitative data collection in social science. In A. Bowlingand S. Ebrahim (Eds) *Handbook of health research methods*. Maidenhead: Open University Press, 215-229.

Charmaz, K. (2006) *Constructing grounded theory.* London: Sage.

Cheek, J. and Jones, J. (2003) What nurses say they do and need: implications for the educational preparation of nurses. *Nurse Education Today*, **23** (1): 40 – 50.

Clancy, J., McVicar, A. and Bird, D. (2000). Getting it right? An exploration of issues relating to the biological sciences in nurse education and nursing practice. *Journal of Advanced Nursing,* **32** (6): 1522 -1532.

Clarke, M. (1995) Nursing and the biological sciences. *Journal of Advanced Nursing,* **22**: 405 – 406.

Cohen, L., Manion, L. and Morrison, K. (2000) *Research methods in education* (5th ed). London: Routledge Farmer.

Considine, J., Botti, M. and Thomas, S. (2007) The effect of education on hypothetical and actual oxygen administration decisions. *Nurse Education Today*, **27**: 651 –660.

Courteney, M. (2002) Nurse prescribing: implications for the life sciences in nursing curricula. *Nurse Education Today,* **22**: 502 - 506

Courteney, M. (1991) A study of the teaching and learning of the biological sciences in nursing education. *Journal of Advanced Nursing,* **16**: 1110 - 1116

Danielson, E. and Berntsson. L. (2007) Registered nurses' perceptions of educational preparation for professional work and development in their profession. *Nurse Education Today*, **27** (8): 900 – 8.

Dart, B. (1997) Adult learners metacognitive behaviour in higher education. In P. Sutherland(Ed). *Adult learning, a reader*. London: Kogan Page, pp30-43.

Davies, S., Murphy, F. and Jordan, S. (2000). Bioscience in the pre-registration nursing curriculum: finding the right teaching strategy. *Nurse Education Today,* **20** (2): 123 – 135.

Deans, C., Congdon, G. and Sellers, E.T. (2003) Nurse education in English Universities in a period of change: expectations of nurse academics for the year 2008. *Nurse Education Today*, **23**: 146 – 154.

Denzin, N.K. and Lincoln, Y.S. (Eds) (2000) *Handbook of qualitative research* (2nd ed). London: Sage.

Department of Health (2006) *Modernising Nursing Careers – setting the direction*. London: DoH.

Department of Health (2007a) *Towards a framework for post-registration nursing careers: a national consultation*. London: DoH.

Department of Health (2007b) *Creating an interprofessional workforce – an education and training framework for health and social care in England*. London, DoH.

Department of Health (2004) *The NHS knowledge and skills framework and the development review process.* London: DoH

Doyle, D. (2007) Transdisiplinary enquiry: researching with rather than on. In A. Campbelland S. Groundwater-Smith(Eds) *An ethical approach to practitioner research*. Abingdon: Routledge, pp75-87.

Draper, J. and Clark, L. (2007) Impact of continuing professional education on practice: The rhetoric and the reality. *Nurse Education Today*, **27**: 515 – 517.

Driver, R. (1988) A constructivist approach to curriculum development. In P. Fensham (Ed) *Development and dilemmas in science education*. Lewes: Falmer Press, pp133-149.

Driver, R. and Bell, B. (1986) Students' thinking and the learning of science. *School Science Review*, 3: 443-456.

Eisenhardt, K. (2002) Building theories from case study research. In A.M.Hubermanand M.B.Miles (Eds) *The qualitative researcher's handbook.* London: Sage, pp8-31.

Eraut, M. (2004) Informal learning in the workplace, *Studies in Continuing Education*, **26** (2) 247 – 384.

Eraut, M. (1997) Developing expertise in school management and teaching. In L. Kydd, , M. Crawford and C. Riches (Eds) *Professional Development for Educational Management*. Buckingham: Open University Press, pp37-49.

Eraut, M., Alderton, J., Boylan, A. and Wraight, A. (1995). ENB Researching Professional Education series. Research report 3. *Learning to use scientific knowledge in education and practice settings: an evaluation of the contribution of the biological, behavioural and social sciences to pre-registration nursing and midwifery programmes*. London: English National Board for Nursing and Midwifery.

Friedel, J.M. and Treagust, D.F. (2005) Learning bioscience in nursing education: perceptions of the intended and the prescribed curriculum. *Learning in Health and Social Care.* **4** (4): 203 – 216.

Gill, R. (1996) Discourse analysis, practical implementation. In J.T.E. Richardson (Ed) *Handbook of qualitative research methods for psychology and the social sciences.* Leicester: BPS books, pp141-147.

Gillham, B. (2000) *Case study research methods*. London: Continuum books.

Gomm. R., Hammersley, M. and Foster, P. (2000) (Eds) *Case study method*. London: Sage.

Gresty, K.A. and Cotton, D.R.E. (2003) Supporting bioscience in the nursing curriculum: development and evaluation of an online resource. *Journal of Advanced Nursing*, **44** (4): 339 – 349.

Hayward, J.C. and Akinsanya, J.A. (1982) The Role of Biological Sciences in Nurse Education. In S.J. Redfern, A.R. Sissan, J.F. Walker and P.A. Walsh (Eds) *Issues in Nursing Research.* London: Macmillan Press, pp57-73.

Higginbottom, G. (2004) Sampling issues in qualitative research. *Nurse Researcher*, **12** (1): 7 – 19.

Hinchliff, S., Norman, S. and Schober, J. (2003) *Nursing practice and health care*. London: Arnold.

Hoekstra, A., Beijaard, D., Brekelmans, M. and Korthagen, F. (2007) Experienced teachers' informal learning from classroom teaching. *Teachers and Teaching: theory and practice*, **13** (2) 189 – 206

Huberman, A.M. and Miles, M.B. (Eds) (2002) *The qualitative researcher's handbook.* London: Sage.

Janesick, V. (2000) The choreography of qualitative research design. In N.K. Denzin and Y.S. Lincoln (Eds) *Handbook of qualitative research* (2nd ed). London: Sage, pp379-400.

Jordan, S. (1994). Should nurses be studying bioscience? A discussion paper. *Nurse Education Today* **14**: 417 – 426.

Jordan, S., Davies, S. and Green, B. (1999) Bioscience in the pre-registration nursing curriculum: staff and students perceptions of difficulties and relevance. *Nurse Education Today*, **19** (3): 215 – 226.

Jordan, S. and Hughes, D. (1998). Using bioscience knowledge in nursing: actions, interactions and reactions. *Journal of Advanced Nursing,* **27**: 1060 – 1068.

Jordan, S., Philpin, S., Davies, S. and Andrade, M. (2000). The biological sciences in mental health nursing: stakeholders' perspectives. *Journal of Advanced Nursing* **32** (4): 881 - 891

Jordan, S. and Reid, K. (1997) The biological sciences in nursing: an empirical paper reporting on the applications of physiology to nursing care. *Journal of Advanced Nursing,* **26**: 169 – 179.

Kevern, J. and Webb, C. (2004) Mature women's experiences of preregistration nurse education. *Journal of Advanced Nursing*, **43** (3): 297 – 306.

Kleiman, S. (2004) Phenomenology: to wonder and search for meanings. *Nurse Researcher*, **11** (4): 7 – 19.

Knowles, M. (1996) Andragogy: an emerging technology for adult learners. In R. Edwards, A. Hanson and H.P. Ragga (Eds) *Boundaries of Adult Learning.* London: Routledge, pp82-98.

Knowles, M., Elwood, F.H. and Swanson, R.A. (2005). The adult learner: (electronic resource) *The definitive classic in adult education and human resource development,* (6th ed) Amsterdam: Elsevier.

Kolb, D. (1984) *Experiential learning: Experience as a source of learning and development*. New York: Prentice Hall.

Latter, S., Maben, J., Myall, M. and Young, A. (2007) Evaluating nurse prescribers' education and continuing professional development for independent prescribing practice: Findings from a national survey in England. *Nurse Education Today,* **27**: 685 – 696.

Laws, S., Harper, C. and Marcus, R. (2003) *Research for development.* London: Sage.

Lincoln, Y.S. and Guba, E.G. (2002) Judging the quality of case study reports. In A.M. Huberman and M.B. Miles (Eds) *The qualitative researcher's handbook.* London: Sage, pp205-216.

Lincoln, Y.S. and Guba, E.G. (2000) The only generalisation is: there is no generalisation. In R. Gomm, M. Hammersley and P. Foster (Eds) *Case study method*. London: Sage, pp27-44.

Linn, M.C. and Songer, N.B. (1993) Cognitive and conceptual change in adolescence. In D. Edwards, E. Scanlon and D. West (Eds) *Teaching learning and assessment in science education*. London: Paul Chapman, pp139-170.

Lofland, J. (2002) Analytic ethnography. In A.M. Huberman and M.B. Miles (Eds) *The qualitative researcher's handbook.* London: Sage, pp137-170.

Manias, E. and Bullock S. (2002) The educational preparation of undergraduate nursing students in pharmacology: clinical nurses' perceptions and experiences of graduate nurses' medication knowledge. *International Journal of Nursing Studies*, **39**: 773 – 784.

Maxwell, J. A. (2002) Understanding and validity in qualitative research. In A.M. Huberman and M.B. Miles (Eds) *The qualitative researcher's handbook.* London: Sage, pp37-64.

McCarey, M., Barr, T. and Rattray, J. (2007) Predictors of academic performance in a cohort of pre-registration nursing students. *Nurse Education Today*, **27:** 357 – 364.

McKee, G. (2002) Why is biological science difficult for first-year nursing students? *Nurse Education Today*, **22**: 251 – 257.

Mezirow, J. (1997) Contemporary paradigms of learning. In P. Sutherland (Ed) *Adult learning, a reader.* London: Kogan Page, pp2-13.

Miles, M.B. and Huberman, A.M. (1994) *Qualitative data analysis* (2nd ed), London: Sage.

Miles, M.B. and Huberman, A.M. (2002) *The qualitative researcher's companion.* London: Sage.

Mockler, N. (2007) Ethics in practitioner research: dilemmas from the field. In A. Campbell and S. Groundwater-Smith (Eds) *An ethical approach to practitioner research*. Abingdon: Routledge, pp88-98.

Mooney, M. (2007) Facing registration: The expectation and the unexpected. *Nurse Education Today*, **27**: 840 – 847

Morrison-Griffiths, S., Snowden, M.A. and Pirmohamed, M. (2002) Pre-registration nurse education in pharmacology: is it adequate for the roles that nurses are expected to fulfil? *Nurse Education Today*, 22: 447 – 456.

Norman, G.R., van der Vleuten, C.P.M. and Newble, D (2002) (Eds) *International handbook of research in medical education*. London: Kluwer Academic Publishers.

NHS (2007) Student bursaries. Accessed on line 12.12.07 at www.nhspa.gov.uk/sgu

Nursing and Midwifery Admissions Service (NMAS), *www.nmas.ac.uk* accessed 8.5.07

Nursing and Midwifery Council (2004) Standards *of proficiency for pre-registration nursing education*. London: NMC.

Nursing and Midwifery Council (2006a) *NMC Reviewer Handbook.* London: NMC.

Nursing and Midwifery Council (2006b) *Standards of proficiency for nurse and midwife prescribers.* London: NMC.

Nursing and Midwifery Council (2006c) *Standards to support learning and assessment in practice.* London: NMC.

Nursing and Midwifery Council (2007) A review of pre-registration nursing education. Accessed on line 15.1.08 at http://www.nmc-uk.org/aArticle.aspx?ArticleID=2641

Potter, J. (1996) Discourse analysis and constructionist approaches: theoretical background. In J.T.E. Richardson (Ed) *Handbook of qualitative research methods for psychology and the social sciences.* Leicester: BPS books, pp125-140.

Priest, H. (2004) Phenomenology. *Nurse Researcher*, 11 (4): 4 – 6.

Prowse, M.A. and Heath, V. (2005) Working collaboratively in health care contexts: the influence of bioscientific knowledge on patient outcomes. *Nurse Education Today*, **25**: 132 –139.

Punch, K.F. (2005) *Introduction to social research* (2nd ed). London: Sage.

Quality Assurance Agency (2001) *Subject benchmark statements: Health care programmes.* Gloucester, QAA.

Quinn, F. (2000) *Principles and practice of nurse education* (4th ed). Cheltenham: Nelson Thornes.

Quinn, F. and Hughes, S.J. (2007) *Principles and practice of nurse education* (5th ed.) Cheltenham: Nelson Thornes.

Reece, I and Walker, S. (2000) *Teaching training and learning*. Sunderland: Business Education Publishers.

Reed, J and Proctor, S. (1993) *Nurse education, a reflective approach*. London: Edward Arnold.

Richardson, J.T.E. (Ed) (1996) *Handbook of qualitative research methods for psychology and the social sciences.* Leicester: BPS books.

Richardson, L. (2000) Writing: a method of inquiry. In N.K. Denzin and Y.S. Lincoln (Eds) *Handbook of qualitative research* (2nd ed). London: Sage, pp923-948.

Rochester, S., Kilstoff, K. and Scott, G.L. (2005) Learning from success: improving undergraduate education through understanding the capabilities of successful nursing graduates. *Nurse Education Today*, **25** (3): 181 – 188.

Rogers, C. (1983) *Freedom to learn*. Columbus: Merrill.

Saks, M. and Allsop, J. (Eds) (2007) *Researching health*. London: Sage.

Salvage, J. (2003) Nursing today and tomorrow. In S. Hinchliff, S. Norman and J. Schober (Eds) *Nursing practice and health care* (4th ed). London: Arnold, pp1-24.

Schön, D. (1996) From technical rationality to reflection-in-action. In R. Edwards, A. Hanson and H.P. Ragga (Eds) *Boundaries of Adult Learning.* London: Routledge, pp8-31.

Seibold, C. (2006) Discourse analysis: integrating theoretical and methodological approaches. *Nurse Researcher*, **14** (1): 18 – 33.

Sim, J. and Wright, C. (2000) *Research in Health Care*. Cheltenham: Nelson Thornes.

Smith, P. (1989) Non-nurse college graduates in a specialty master's program: a success program. *Nursing and health care*, **10**: 495 – 497.

Speziale, H.J.S. and Carpenter, D.R. (2007) *Qualitative research in nursing* (4th ed). London: Lippincott, Williams and Wilkins.

Strauss, A. and Corbin, J. (1990) *Basics of qualitative research, grounded theory procedures and techniques.* London: Sage.

Strauss, A. and Corbin, J. (1998) *Basics of qualitative research, techniques and procedures for developing grounded theory.* London: Sage.

Tarling, M. (2002) Disseminating research findings. In M. Tarling and L. Crofts (Eds) *The essential researcher's handbook* (2nd ed). Edinburgh: Bailliere Tindall, pp178-193.

Thompson, D.R. and Watson, R. (2005) All bathwater and no baby: revisiting a national curriculum and state examination for nursing? Nurse Education Today, **25** (3): 165 – 166.

Trnobranski, P.H. (1993) Biological sciences and the nursing curriculum: a challenge for educationalists. *Journal of Advanced Nursing* **18**: 493 – 499

Van Maanen, J. (2002) The fact of fiction in organizational ethnography. In A.M. Huberman and M.B. Miles (Eds) *The qualitative researcher's handbook.* London: Sage, pp101-118.

Watson, R. (2006) Is there a role for higher education in preparing nurses? *Nurse Education Today*, **26**: 622 – 626.

Wharrad, H.J., Allcock, N. and Chapple, M. (1994) A survey of the teaching and learning of biological sciences on undergraduate nursing courses. *Nurse Education Today* **14**: 436 – 442.

Wilson, K.J.W., (1975). *A study of the biological sciences in relation to nursing*. Edinburgh: Churchill Livingstone.

World Health Organisation (1956) *Basic nursing curriculum in Europe.* Geneva: World Health Organisation.

Wynne, N., Brand, S. and Smith, R. (1997) Incomplete holism in pre-registration nurse education: the position of the biological sciences. *Journal of Advanced Nursing,* **26**: 470 – 474.

Yin, R. (1993) *Applications of case study research*. London: Sage.

Yin, R. (2003) *Case study research: design and methods*. London: Sage.

Appendix A – Questionnaire used

Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme

Data sheet

This data will be removed from the completed questionnaire when a code number has been allocated.

Participant's name _____

Have you signed the consent form? Yes or No

Yes →	**Please proceed to the questionnaire on the next page**
No →	**If you wish to participate in this study, please sign the consent form**

For office use only

Participant code number _____

Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme

For office use only Participant code number _____

Questionnaire

Please complete all components.

1. What age group are you in? Tick one box only.

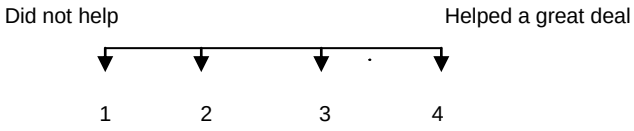
21 – 25 years	
26 – 30 years	
31 – 35 years	
36 – 40 years	
41 – 45 years	
46 – 50 years	
51 – 55 years	
56 – 60 years	

2. What year did you start your training as a registered nurse? (Insert actual year, e.g. 1979, 1985, 2001)

3. How many years have you been working as a registered nurse? Tick one box only.

Less than 5 years	
5 - 10 years	
11 - 15 years	
16 – 20 years	
21 – 25 years	
26 – 30 years	
More than 30 years	

4. Please tick any of the qualifications which you had before you started your training, then write a number from the scale to indicate the usefulness of the qualification in helping you learn bioscience during your training.



Qualification	Tick if completed before nurse training	Use the scale and write in a number to indicate whether the course helped you to learn bioscience during your pre-registration training.
GCSE or O level biology or science		
A level biology		
Access to Nursing		
Other Access course (please state subject)		
National Diploma in Health		
Other National Diploma (please state subject)		
NVQ Care		
Other NVQ (please state subject)		
University degree (please state subject)		
University diploma (please state subject)		
Any other relevant qualification – (please state)		

If you would like to comment, please do so here:

5. Please indicate your views of the bioscience content of your pre-registration nurse training programme – tick one box from each group of three.

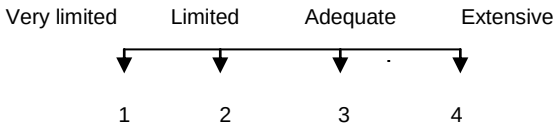
The bioscience content was extensive	
The bioscience content was adequate	
The bioscience content was limited	

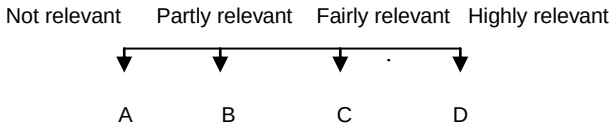
The bioscience was usually related to nursing practice	
The bioscience was related to nursing practice some of the time	
The bioscience content was rarely related to nursing practice	

The bioscience in my pre-registration programme prepared me well for my role as a registered nurse	
The bioscience in my pre-registration programme prepared me adequately for my role as a registered nurse	
The bioscience in my pre-registration programme did not adequately prepare me for my role as a registered nurse	

If you would like to comment, please do so here:

6. Please select a number and letter from the scales to answer each of these questions. The first column asks how well you think the topic was covered in the pre-registration curriculum, the second column asks you whether you think the topic is relevant in the pre-registration curriculum.





	Coverage (choose a number from the scale)	Relevance (choose a letter from the scale)
Inclusion of anatomy in the pre-registration curriculum		
Inclusion of physiology in the pre-registration curriculum		
Inclusion of microbiology in the pre-registration curriculum		
Inclusion of pharmacology in the pre-registration curriculum		
Inclusion of biochemistry in the pre-registration curriculum		

If you would like to comment, please do so here:

7. How confident were you in your knowledge of bioscience when you started the nurse prescriber programme? Please tick one box in each row.

	I had very little confidence in my knowledge of this subject	I had some confidence in my knowledge of this subject	I had confidence in my knowledge of this subject
Overall knowledge of anatomy			
Overall knowledge of physiology			
Overall knowledge of microbiology			
Overall knowledge of pharmacology			
Overall knowledge of biochemistry			

8. What area of nursing do you consider to be your specialism?

My area of specialism is _____ .

9. Please give your job title _____ .

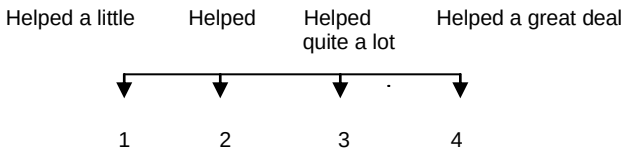
10. How much knowledge of bioscience do you consider you need in relation to your current job as a nurse? Please tick one box in each row.

	I need very little knowledge of this subject to carry out my job	I need some knowledge of this subject to carry out my job	I need a lot of knowledge of this subject to carry out my job
Knowledge of anatomy			
Knowledge of physiology			
Knowledge of microbiology			
Knowledge of pharmacology			
Knowledge of biochemistry			

11. How confident are you in your knowledge of bioscience in relation to your current role as a nurse? Please tick one box in each row.

	I don't need this subject for my current role	I have very little confidence in my knowledge of this subject	I have some confidence in my knowledge of this subject	I am confident of my knowledge of this subject
Knowledge of anatomy in relation to current role				
Knowledge of physiology in relation to current role				
Knowledge of microbiology in relation to current role				
Knowledge of pharmacology in relation to current role				
Knowledge of biochemistry in relation to current role				

12. Place a tick against any factor which you consider has helped you to learn biosciences knowledge. Then choose a number from the scale to indicate how helpful this was.



	Tick if this helped you to learn bioscience	Use a number from the scale to indicate how helpful it was to your work as a nurse
Teaching during pre-registration nurse training		
Teaching during post-registration programmes		
Finding out information from books, the internet, or other written sources		
Finding out information from colleagues		
Finding out information due to experiences in the workplace		
Other factors (please list)		

If you wish to comment, please do so here:

Thank you for your time.

Appendix B – Specialisms of Nurse Prescriber students (as stated by the Nurse Prescriber student, some occurred more than once)

Asthma
Chronic obstructive pulmonary disease
Breast surgery
Cardiology
Community/Primary care
Diabetes
Emergency care
General practice
Intensive care
Long-term conditions
Medical nursing
Mental health
Neurology
Oncology
Palliative care
Rehabilitation
Respiratory nursing
Sexual health
Tissue viability

Appendix C – Job titles of Nurse Prescriber students (some occurred more than once)

Care co-ordinator
Clinical nurse specialist
Community staff nurse
Community matron
District nurse
Lead – Long-term conditions
Night matron
Nurse practitioner
Manager
Practice development nurse
Practice nurse
Senior staff nurse
Sexual health advisor
Sister

Appendix D

FORM OF CONSENT TO TAKE PART IN A RESEARCH PROJECT - Questionnaire

CONFIDENTIAL

Title of project / investigation:

Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme.

Brief outline of project, including an outline of the procedures to be used:

The study aims to explore students' confidence in their knowledge of biosciences and to explore the ways in which nurses have acquired their knowledge of bioscience. The participants will be drawn from the students on Nurse Prescriber programmes at one University. Students will be asked to complete a short questionnaire. Data will be analysed using computer software. Data will be stored in a locked cupboard, electronic data will be password protected and accessible only by the researcher. The questionnaire will not include the name or address or contact details of the participant. Confidentiality of the participant will be maintained. Participation in this research will not impact on any final assessment.

Please read the attached information sheet before deciding whether to participate in this project. You are not obliged to participate. If you decide to participate, please sign this consent form.

I, ... *(**participant's** full name) agree to take part in the above named project / investigation, the details of which have been fully explained to me and described in writing.

Signed ..... Date.....
(Participant)

I, ... *(**Investigator's** full name) certify that the details of this project / investigation have been fully explained and described in writing to the subject named above and have been understood by him / her.

Signed ..... Date.....
(Investigator)

FORM OF CONSENT TO TAKE PART IN A RESEARCH PROJECT - interview

CONFIDENTIAL

Title of project / investigation:
Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme.

Brief outline of project, including an outline of the procedures to be used:

The study aims to explore students confidence in their knowledge of biosciences and to explore the ways in which nurses have acquired their knowledge of bioscience. The participants will be drawn from the students on Nurse Prescriber programmes at one University. Tape recorded, semi-structured interviews lasting approximately one hour each will be used for data collection. Tapes will be stored in a locked cupboard accessible only to the researcher and the administrator. Data will be analysed using computer software. After the interview, the administrator or myself will transcribe the tape. Your personal details will not be included in the transcript. The transcript and tape will be coded to ensure the same individuals are not unintentionally asked again. Once completed, only the researcher will hold transcripts. Transcripts will be password protected and only accessible by the researcher. Confidentiality of the participant will be maintained. Participation in this research will not impact on any final assessment.

Please read the attached information sheet before deciding whether to participate in this project. You are not obliged to participate. If you decide to participate, please sign this consent form.

I, ... *(**participant's** full name) agree to take part in the above named project / investigation, the details of which have been fully explained to me and described in writing.

Signed ..... Date.....
(Participant)

I, ... *(**Investigator's** full name) certify that the details of this project / investigation have been fully explained and described in writing to the subject named above and have been understood by him / her.

Signed ..... Date.....
(Investigator)

Appendix E

Participant information sheet .

Research project title: Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme.

Information about the study: Please read this information before deciding whether to participate in this project. If you agree to participate after reading this information, please sign the consent form. If you have any questions, please ask me. You can contact me on xxxxx xxxxxx or by email at xxxxxxx adding @xxxxx.xx.uk from outside the university.

You are being asked to participate in a research project. Other students on the Nurse Prescriber programmes are also being asked to participate. I am asking all students to complete a short questionnaire. You are asked to indicate how confident you are with your own bioscience knowledge and state how you acquired your knowledge. I will then interview a small number of students from the programme until no new information is reported. If you volunteer to be interviewed you will be asked for interview only once. The purpose of the research is to find out more about the bioscience knowledge of nurses.

If you attend an interview the interview will be conducted by me and will be tape-recorded. You will be asked to elaborate on the answers you gave on the questionnaire. After the interview, an administrator or myself will transcribe the tape. Your personal details will not be included in the transcript. The transcript and tape will be coded to ensure the same individuals are not unintentionally asked again.

You are not obliged to divulge information. Any information you give will be held securely. Access to this information will be limited to an administrator and myself. All personal information will remain confidential. The storage of all data will be secure and will comply with the Data Protection Act of 1998. Data will be analysed and results will be reported anonymously.

You do not have to agree to participate. If you decide you do not want to participate, you will not be treated differently from those students who do decide to participate. If you initially agree to participate and then change your mind, you can withdraw from the study at any time – simply let me know, you will not be asked for a reason.

If you are happy to participate in the study, please sign the consent form.

Name of researcher

Department of xxxxxxx,
University of xxxxxxx.

Appendix F

UNIVERSITY OF XXXXX

APPLICATION FOR ETHICAL APPROVAL OF RESEARCH INVOLVING HUMAN PARTICIPANTS

CONFIDENTIAL

This form should be completed in typescript or print for **any** research project involving human participants conducted in the University. It should then be passed to your Departmental Administrator, together with a copy of your research proposal and any necessary supporting documentation (e.g. consent form, recruiting materials, etc).[i]

1. Name of Investigator:

   Geraldine Davis

2. Title of project:

   Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme.

3. The title of your project will be published in the minutes of the Ethics Committee. However, if you object to this a reference number will be used in place of the title. Do you object to the title of your project being published? No

4. Brief outline of project

   The study aims to explore the confidence of nurses in their bioscience knowledge and to discover how this knowledge was acquired. The participants will be drawn from the students on the Nurse Prescriber programmes. A semi-structured questionnaire will be used for all participants, interviews will be held with some participants using a case study approach**.**

   (a) Purpose or objective:

   The objectives are to identify the confidence experienced nurses entering the nurse prescriber programme have in their bioscience knowledge and to describe the formal and informal means by which this knowledge was acquired.

   (b) Start date: Study to run from March 2007 to December 2008. Data collection from February to September 2007.

   (c) Probable duration: 18 months.

5. Where the project is to be undertaken: At the University of XXXXX. Interviews to be conducted in the investigators office.

6. Outline of procedures to be used (*you may continue on a separate sheet if necessary*): Tape recorded semi-structured interview will be used for data collection. Computer software will be used for analysis.

7. Are there potential hazards to participants in these procedures? No

8. If "Yes":

(a) What is the nature (give full details)?

(b) What precautions will be taken to meet them?

9. (a) May the procedures cause discomfort? No

(b) May the procedures cause distress? No

10. If "Yes"

(a) What is the nature and extent?

(b) What steps will be taken to minimise any discomfort and / or distress?

11. Where the procedures involve potential hazard, discomfort or distress, please state previous experience with this type of research.

12. Is electrical / electronic equipment to be connected to the subject? No

13. If "Yes" what steps have you taken to assure yourself of its safety?

14. How will participants be recruited? If any recruiting materials are used, please attach copies.

Purposive sampling will be used. Students on any of the Nurse Prescriber programmes could be asked to participate. Requests will be made directly to individual students.

15. (a) How will the participant's consent be obtained? (if you are not using the standard consent form, please attach example of written consent for approval)

The standard consent form will be used.

(b) How fully will he / she be briefed on the nature of the experiment before giving his/her consent?

The participants will be fully briefed. A participant information sheet is included in the proposal.

16. Will it be made clear to the participant that he / she may withdraw from the experiment at any time without giving any reason. Yes

17. If "No", give reasons:

18. Will the participant be paid? No

19. If "Yes" give details, including reasons for payment:

20. Are there any potential benefits for the participant from taking part in this study? No

21. If "Yes", please specify:

22. Any other relevant matters:

This study is part of an educational programme to obtain an EdD from the University of

23. If ethical approval is required in association with a research grant submission please give date by which approval required:

Signature of applicant(s)**

.....……

Name(s) in block capitals

.....……

Position and Department

.....…….

*Approved on behalf of the University Ethics Committee /

Proposal to be considered by the Ethics Committee

Signature of Head of Department

.....……

*Delete as appropriate

**For undergraduate and postgraduate projects both the student and the student's

[i] The Ethics Committee has devolved responsibility to Heads of Departments and Directors of Centres for the ethical approval of certain research proposals. For example, proposals involving the protocols and techniques listed in Appendix IV of the "Guidelines for Ethical Approval of Research Involving Human Participants" will not normally need to be sent to the Ethics Committee for consideration

29 March 2007

Mrs Geraldine Davis
Department of xxxxx
University of xxxxx

Dear Geraldine

Ethics Committee

The Ethics Committee of the University of xxxxx has considered your project proposal entitled *"Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programm"*. The Committee would be content to give a favourable ethical opinion of the research subject to receiving a complete response to the following points that were raised.

1. The title of the project given on the application for ethical approval, the research proposal, the consent form and the participant information sheet do not currently match. These should be amended so that the same title of the research is used throughout the documentation.
2. How do you propose to store the data and how will you ensure that it is kept confidential? This information should be included on the consent form.
3. The Committee would also like to see a statement on the consent form along the lines of "Participation in this research will not impact on any final assessment.".

I should be grateful if you would let me have the revised documentation required to address these points. If anything is not clear, please do not hesitate to contact me (xxxxxxx@xxxxxx.uk).

The Ethics Committee has agreed that Professor xxxxxxx should take Chair's action to approve your application if the documentation you submit is satisfactory.

Yours sincerely

xxxxxxx xxxxxx
Research Governance and Planning Manager

Mrs Geraldine Davis
Department of xxxxxxx
University of xxxxx

Dear Geraldine

Ethics Committee

Thank you for providing the additional information as requested in relation to your project proposal entitled *"Bioscience knowledge and the registered nurse: an exploratory study of nurses starting a Nurse Prescriber programme"*. I am pleased to tell you that xxxxxxxxx found the information that you have submitted satisfactory and, therefore, approved your application on behalf of the Ethics Committee of the University of xxxxx.

Yours sincerely

xxxxxxx
Research Governance and Planning Manager

Appendix G – Schedule of semi structured questions used in semi structured interviews

Introduction and right to withdraw.

1. Biographical data
    a. Could you tell me about your time in nursing, the jobs you have held?
    b. Could you tell me a bit more about your current role?
    c. Can you tell me about your bioscience knowledge before you came into nursing?
2. Bioscience knowledge held and confidence in this
    a. Tell me about your knowledge of these areas in relation to your current role
        i. anatomy
        ii. physiology
        iii. microbiology
        iv. pharmacology
        v. biochemistry
    b. How confident are you in your knowledge in the above areas?
3. How bioscience knowledge has been learned
    a. Tell me how you have gained the knowledge you have about bioscience
    b. How much has your knowledge developed through formal teaching, how much through being at work, how much through non-work activities?

Thanks and assurance of confidentiality.

Bibliography

American Association of Colleges of Nursing (2004) Accelerated programs: the fast track to careers in nursing. AACN issue bulletin.
www.aacn.nche.edu
Accessed 10.7.06

Blaxter, L., Hughes, C. and Tight, M. (2001) *How to research* (2nd ed), Buckingham, Open University Press.

Bonner, A. and Greenwood, J. (2006) The acquisition and exercise of nephrology nursing expertise: a grounded theory study, *Journal of Clinical Nursing*, vol. 15, pp. 480 - 489

Bowling, A. and Ebrahim, S. (Eds) (2005) *Handbook of health research methods*. Maidenhead: Open University Press.

Burgess, R.G. (1993) *Research methods*, Edinburgh, Thomas Nelson.

Chenitz, W.C. and Swanson, J.M. (Eds.) (1986) *From practice to grounded theory*, Wokingham, Addison Wesley.

Dimmock, C. and O'Donoghue, T.A. (1997) *Innovative school principals and restructuring*, London, Routledge.

Erlandson, DA, Harris, EL, Skipper, BL and Allen, SD (1993) *Doing naturalistic inquiry,* London, Sage.

Freebody, P. (2003) *Qualitative research in education*. London, Sage.

Giorgi, A. (1997) The theory, practice and evaluation of the phenomenological method as a qualitative research procedure, *Journal of Phenomenological Psychology*, **28**, (2), 235.

Glaser, B. and Strauss, A. (1967) *The discovery of grounded theory*, Chicago, Aldine.

Hanna, M., Eija, P. and Astedt-Kurki, P. (2003) The use of grounded theory to study interaction, *Nurse Researcher*, **11** (2)40 – 57.

Jones, M.C. and Johnston, D.W. (1997) Distress, stress and coping in first-year student nurses, *Journal of Advanced Nursing*, **26**, 475 – 482.

Leathard, H.L. (2001) Understanding medicines: conceptual analysis of nurses' needs for knowledge and understanding of pharmacology. *Nurse Education Today*, **21** (4): 266 -277.

Lindop, E. (1999) A comparative study of stress between pre-and post-Project 2000 students, *Journal of Advanced Nursing*, **29**, (4), 967 - 973

McCann, T.V. and Baker, H. (2001) Mutual relating: developing interpersonal relationships in the community, *Journal of Advanced Nursing*, **34** (4),530 – 537.

McCann, T.V. and Clark, E. (2003) Grounded theory in nursing research, *Nurse Researcher*, **11** (2) 7 – 39.

Morse, J.M. (2001) Situating grounded theory within qualitative inquiry. In Schreiber, R.S. and Stern, P.N. (Eds) *Using grounded theory in nursing*, New York, Springer

Stern, P.N. (1994) Eroding grounded theory. in Morse, J.M. (ed) *Critical issues in qualitative research methods*, London, Sage.

Taylor, S.J. and Bogdan, R. (1984) *Introduction to qualitative research methods* (2nd ed), Chichester, John Wiley.

Watson, R. (2002) Clinical competence: Starship Enterprise or straitjacket? *Nurse Education Today*, 22: 476 – 480.

Wink, D.M. (2005) Accelerated nursing programs for non-nursing college graduates. *Annual review of nursing education*, **3**: 271 – 297.