A QUANTITATIVE INVESTIGATION INTO THE RELATIONSHIP BETWEEN NURSING STUDENTS' LEARNING STYLE AND SUCCESS IN BIOSCIENCE EDUCATION

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Abstract

Bioscience concepts are integral in the provision of nursing care. Despite the importance of these concepts, nursing students appear to be unable to apply and integrate bioscience concepts into nursing care, or demonstrate appropriate knowledge of physiological processes. Consequently, nursing educators are challenged to effectively facilitate a comprehensive bioscience education that meets the unique needs of this student cohort.

Nursing students experience significant andragogic barriers in the learning of bioscience concepts. However, the processes, strategies, or styles that nursing students employ in their bioscience learning has not been identified or explored; as such its influence on student achievement is unknown.

The aim of this study was to determine whether identified learning styles denote achievement in the bioscience education of Registered Nurses. The key objectives were to: (1) ascertain the dominant learning styles used by nursing students in their study of bioscience; (2) explore whether student characteristics are determinants of either learning styles or student achievement; and (3) to determine if any specific learning styles correlate with higher academic achievement in bioscience education.

A cross-sectional research design was employed in this study. Data was collected from a purposive, convenience sample of 39 undergraduate nursing students from both a metropolitan and a satellite university campus. Data collection occurred over a one month period from March until April 2016 utilising an online survey. The data was analysed using descriptive statistics, the Kruskall-Wallis H Test, Fisher's Exact Test and Spearman's Rho Correlation Coefficient.

The dominant learning styles employed by nursing students included Reflectors (59%, n=23), Theorists (15%, n=6), Pragmatists (10%, n=4), and various multimodal combinations 15% (n=6). The multimodal combinations (15%) included Reflector/Pragmatist (n=1), Pragmatist/Activist (n=1), Reflector/Theorist (n=3), Theorist/Pragmatist (n=1). The dominant learning style employed with the highest frequency was Reflector, yet this style did not produce the highest mean GPA (5.69,

SD 1.09). The results demonstrated no correlation between the learning styles employed in bioscience and academic achievement, $r_s(30)=0.033$; ($p=0.856$).

No association was found between the nursing students learning style and their inherent student characteristics. Furthermore no association was found between the inherent student characteristics and their academic achievement. Whilst the Reflector learning style was identified as the dominant learning style employed with the highest frequency, multiple learning styles were used including several multimodal combinations. This variation may indicate a need for a blended teaching approach. Indeed, nursing student learning in bioscience appears to be both complex and multifaceted.

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List of Abbreviations

AHPRA	Australian Health Practitioner Regulation Agency
ANMAC	Australian Nursing and Midwifery Accreditation Council
CASP	Critical Skills Appraisal Program
CINAHL	Cumulative Index to Nursing and Allied Healthcare Literature
DV	Dependent Variable
ECG	Electrocardiogram
ERIC	Education Resources Information Centre
GPA	Grade Point Average
ICN	International Council of Nurses
IV	Independent Variable
LSI	Learning Style Inventory
MBTI	Myers-Briggs Type Indicator
MESH	Medical Subject Headings
NESB	Non-English Speaking Background
NHMRC	National Health and Medical Research Council- Level of evidence
NMBA	Nursing and Midwifery Board of Australia
NS	National Standards
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QUT	Queensland University of Technology
SPSS	Statistical Package for the Social Sciences
VARK	Visual Aural Read/Write Kinaesthetic

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: QUT Verified Signature

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Chapter 1: Introduction

Bioscience can be defined as the interwoven, science-based concepts taught to nursing students. Bioscience includes the fields of pathophysiology, anatomy, physiology, microbiology, pharmacology and organic chemistry. Bioscience is clinically relevant to nursing practice; despite this, nursing students appear to be deficient in their bioscience knowledge. This chapter provides background information regarding the problems identified in the bioscience education of nursing students (section 1.1) and provides a frame of context for these problems (section 1.2). The research aims and objectives are stated in section 1.3. These research objectives include exploring nursing student cohort characteristics and their influence on both nursing students' learning styles and academic achievement in bioscience. Moreover, an exploration of the methods through which nursing students learn bioscience material and its subsequent relationship with academic achievement will follow. Section 1.4 delineates the rationale for this research including its significance and scope. Section 1.5 discusses common terminology used throughout the study, while section 1.6 provides an overview of the study by outlining the subsequent chapters included in this thesis. Section 1.7 concludes with a concise summary of the chapter.

1.1 BACKGROUND

Bioscience has been labelled as a cornerstone of nursing practice (McVicar, Andrew & Kemble, 2014). Bioscience concepts are integral in key nursing responsibilities, such as undertaking physiological assessments, identifying primary care priorities, the formation of patient care plans, the implementation of appropriate interventions and the evaluation of the efficacy of treatment (McVicar et al., 2014). Indeed, bioscience provides the evidence base behind many interventions used to address physiological changes in the patient condition, including the provision of observable data to determine an intervention's efficacy (Smales, 2010). This process of clinical reasoning requires a comprehensive understanding of bioscience theory (McVicar et al., 2014).

1.2 CONTEXT

Undergraduate nursing students require an in-depth knowledge of the biosciences in order to provide effective and safe nursing care (Smales, 2010). Indeed, utilising bioscience knowledge to guide nursing care is a requirement of the Registered Nurse Standards for Practice (NMBA, 2016) which is enforced by governing nursing bodies. These governing bodies include the Australian Nursing and Midwifery Accreditation Council (ANMAC), the Nursing and Midwifery Board of Australia (NMBA) and the Australian Health Practitioner Regulation Agency (AHPRA). The NMBA and AHPRA develop standards and guidelines for nursing practice and ensure Registered Nurses are compliant with these requirements (NMBA, 2016).

ANMAC develops accreditation standards and reviews nursing program providers' curriculum to ensure their program of study meets the minimum requirements where upon course completion their nursing students are deemed competent and are therefore able to attain registration for nursing practice within Australia (ANMAC, 2012). This includes ensuring program providers provide education that complies with the Registered Nurse Standards for Practice. These standards delineate the expectations and responsibilities of Registered Nurses, which include maintaining patient safety, conducting comprehensive physical examinations, assessing changes in patient physiological condition and initiating therapeutic interventions based on an accurate interpretation of the data (NMBA, 2016).

There have been concerns that nursing students are unable to comprehend, retain, and competently apply and integrate bioscience theory to the standard required for safe clinical practice (Craft, Hudson, Plenderleith, Wirihana & Gordon, 2013; McVicar, Andrew & Kemble, 2015; Smales, 2010). Nursing students have reported experiencing significant difficulties in their learning of bioscience concepts (Smales, 2010). The barriers experienced by nursing students in learning bioscience content, integrating and applying this theory to practice, pose a significant concern in regards to patient safety and health outcome. Nursing students who are deficient in their bioscience knowledge may translate into incompetent and therefore unsafe Registered Nurses that are unable to meet the standards required for nursing practice within Australia (McVicar, Clancy & Mayes, 2010).

As undergraduate nursing students experience challenges in their learning of bioscience concepts an exploration of the methods through which they learn or their learning style is warranted. Learning style theories are based on the premise that different forms of educational instruction may be effective for some and ineffective for others depending on their personal characteristics and therefore in consideration of their learning style the students' achievement may be dependent on how education is facilitated (Blevins, 2014; Searson & Dunn, 2001).

To address this dilemma, this quantitative study explored nursing cohort characteristics and the learning styles nursing students employed in their bioscience learning. These variables were explored to determine if a statistically significant correlation existed between the learning styles employed by nursing students in their bioscience study and their subsequent academic achievement in bioscience.

1.3 RESEARCH AIM AND OBJECTIVES

There appears to be a lack of literature that explores the learning processes, and specifically the learning styles, used by nursing students to understand bioscience concepts. Any influence that learning styles may have on nursing student achievement in bioscience is also unknown. Therefore, this study aimed to explore the student cohort characteristics of undergraduate nursing students as a determinant of learning styles. This study identified the learning styles that nursing students utilised in the bioscience component of their nursing program, and explored the relationship between these learning styles and academic achievement. The research objectives of this project were:

1. to explore the different learning styles adopted by nursing students in their study of the bioscience subjects;
2. to identify whether student characteristics influence:
    a. the learning styles employed, or
    b. the achievement of nurses in bioscience education; and
3. to identify if particular learning styles correlate with higher academic achievement in bioscience compared to others.

The practical outcome of this study was to provide information that may assist in the development of (1) the bioscience curriculum for nursing students, (2) innovative teaching approaches, and (3) student-focussed learning support strategies.

1.4 RATIONALE

With the increased demand on the healthcare system and the global nurse shortage, the education of nursing students and their ability to learn, integrate and apply bioscience knowledge is a contemporary concern (McVicar et al., 2014). This bioscience problem, though heavily documented, remains largely unresolved. Therefore, studies that aim to understand the complexities and influences of nursing student learning in bioscience may provide essential insights to positively influence the teaching and learning of undergraduate nursing students in their bioscience units.

The strategies that nursing students employ to learn the bioscience content within their undergraduate nursing program are unknown. The way in which a student prefers to learn can be described as their learning style, and the influence of the students learning style on academic achievement within bioscience is also unclear. Therefore, this study used a cross-sectional research design to provide an initial exploration into the learning styles and study strategy of nursing students, specifically in relation to their bioscience education. This research makes a valuable contribution to the lack of knowledge surrounding the nursing student learning experience in bioscience. These findings may have implications for nursing educators, and learning support structures in regards to curriculum delivery, development, teaching strategy and learning support programs.

1.5 TERMINOLOGY

Bioscience

This term is used to describe the interwoven science-based concepts taught to nursing students which includes pathophysiology, anatomy, physiology, microbiology, pharmacology and organic chemistry.

Registered Nurse

This term defines a nurse who meets the required registration standards for practice in Australia. The Australian Institute of Health and Welfare (2017) define a Registered Nurse as A nurse who is on the AHPRA and NMBA register. The

minimum educational requirement for a registered nurse is a 3-year degree from a higher education institution or equivalent from a recognised hospital-based program (AIHW, 2017).

Undergraduate Nursing student

Nursing student refers to a student who is undertaking a Bachelor of Nursing degree. This degree must be from an accredited institution where the course structure meets the minimum requirements that upon completion, the student can apply for registration with NMBA and AHPRA to practice within Australia.

Nurse academic

A university based teacher who teaches into the undergraduate nursing program into nursing theory or clinical skills subjects.

Educator

A generic term for a university based teacher who teaches into the undergraduate program in any capacity, in any subject, such as nursing practice or bioscience theory.

Bioscientist

A university based teacher who teaches into the undergraduate nursing program into only the bioscience theory subjects, usually with no clinical or academic nursing background.

Undergraduate nursing course or Bachelor of Nursing

A program of study which has undergone an accreditation process; upon course completion it allows the student to meet the requirements for a Bachelor of Nursing and nursing registration within Australia.

1.6 THESIS OUTLINE

This thesis contains six chapters, with each chapter delineating a specific stage in the research process. Chapter one briefly contextualises the research by outlining the background, aims, and significance of the study. It continues to provide a rationale detailing the importance of research in the area of bioscience education in nursing. Chapter two, through its search protocol, presents an integrative review of the current literature identifying the problems associated with bioscience teaching and learning, and learning styles theories. The review employs a critical appraisal of

the literature and a thematic analysis to identify consistent ideologies that are employed to develop a conceptual model of nursing student learning in bioscience.

Chapter three details the methodology used in the study, including the research design and the procedures employed in online survey research. The participants, sampling method and setting are discussed. Statistical analysis procedures are delineated and ethical considerations including anonymity, confidentiality and consent are outlined. Chapter four provides a detailed overview of the participant demographics. The key findings from the study in relation to the research objectives and the underpinning research aim are also reported and supported through the statistical analysis procedures employed.

Chapter five discusses these results in relation to the themes identified in the literature review. This chapter also highlights the contribution this research has provided to guide the teaching and learning of nurses in bioscience. Chapter six concludes the thesis by outlining the implications, recommendations and future directions for bioscience education in nursing, for the continuation of research and for clinical practice.

1.7 SUMMARY

Chapter one began by providing background information on the role of the Registered Nurse. The chapter detailed the importance of maintaining a working knowledge of bioscience in order to provide safe effective care that aligns with the Registered Nurses' responsibilities set out by its governing agencies. In section 1.2 the major focus of this study was discussed; exploring nursing students' learning styles in relation to their bioscience education, which was followed by the research aims and objectives (section 1.3) and a rationale detailing the significance and scope of the study (section 1.4). Section 1.5 provided brief explanations of nursing terminology and an outline for the subsequent chapters followed (section 1.6). Chapter two will follow with a review of the literature.

Chapter 2: Literature Review

Patient-orientated care is currently the popular model of care employed in the healthcare setting. This model promotes the provision of holistic care that involves the entire multidisciplinary health care team to meet the physical, psychological, social and religious needs of the patient in relation to their health and well-being. Smales (2010) suggest that the provision of nursing care that meets these higher order requirements are only achievable when lower order pathophysiological needs have been met; making a solid grounding in biosciences integral to the provision of health care and to adherence to this holistic care model. Therefore, this chapter begins by providing a background detailing the importance of bioscience in nursing education (section 2.1). The chapter then continues to describe the search protocol used in this literature review (section 2.2). The data extraction process employed resulted in the formation of the main themes which are detailed in section (2.3) which include (1) the bioscience teaching and learning problem and (2) underpinning teaching and learning theories.

The bioscience teaching and learning problem (section 2.4) considers the issues associated with and encountered by nursing students in the learning of bioscience; the underpinning teaching and learning theories (section 2.5) details the varied arguments surrounding learning styles literature. This is followed by a discussion on the various frameworks available for learning style determination, and the appropriateness of their applicability to nursing students' education. Section 2.6 provides a summary of the problem discussed and details the research implications identified from the gaps in the literature. From the literature review a conceptual model was developed (Section 2.7). The gaps in knowledge form the aims for the study and concluding comments from the review (section 2.8).

2.1 BACKGROUND

The International Council of Nurses (ICN) reports that there is a global shortage of tertiary educated nurses, which is a problem that has the potential to result in serious adverse health outcomes (Nardi & Gyurko, 2013). This global Registered Nurse shortage is reflected domestically within Australia. According to

the NMBA (2015) there are 264, 789 Registered Nurses currently practicing within Australia to meet the healthcare demand. From this figure, 48% (n=126 256) of these Registered Nurses are aged between 40-59 years (NMBA, 2015). This statistic indicates an ageing nursing workforce that when combined with the current shortage, creates a community where healthcare needs are unable to be met. Various methods have been implemented to address the demand for healthcare and subsequently Registered Nurses, and to combat the expected global Registered Nurse shortage. These methods include increasing university graduates through widening participation initiatives and easing the entry requirements into undergraduate nursing programs to increase student numbers. These initiatives and the easing of entry requirements promoted a heterogeneous student population with diverse learning needs. Consequently, the preparation and education of Registered Nurses in tertiary institutions has become an important contemporary topic that requires ongoing planning, development and consideration.

Nursing students, upon course completion, must be able to appropriately apply theoretical bioscience concepts to the interventions they initiate in their nursing practice (Smales, 2010). This level of comprehension and integration is required for compliance with the NMBA Registered Nurse Standards for Practice. These National Standards (NS) include recognising that Registered Nurses have the responsibility to prevent harm, and perform nursing interventions following comprehensive and accurate assessments (NS 1.2) (NMBA, 2016, p.2). Furthermore, Registered Nurses need to be able to integrate nursing and allied healthcare knowledge (NS 2.6) and conduct comprehensive and systematic nursing assessments using a range of techniques including physical examinations to form an accurate interpretation of this data (NS 5) (NMBA, 2016, p.4-5). Thus, to (1) maintain registration and (2) fulfil their responsibilities and competencies, and (3) to ensure appropriate interventions are initiated in patient care, nurses must be able to integrate and apply bioscience theory to their clinical practice (Smales, 2010). These standards highlight the importance of nursing students' bioscience education and their consequent preparation for practice. Therefore, the strategies employed by nursing students to successfully learn, integrate and apply bioscience knowledge are an important consideration.

Research by Mayfield (2012) supports the notion that there is a relationship between the learning styles employed by nursing students and their success in academia. Despite this, little research is available that details the methods that pre-registration nursing students utilise in the learning of bioscience. The pathophysiology of disease progression in the human body forms the foundation of interventions that nurses initiate in their care of patients. Thus, retention of bioscience theory and its appropriate application is integral for patient safety (Andrew, McVicar, Zanganeh & Henderson, 2015; McVicar et al., 2014). Research suggests that Registered Nurses' ability to apply bioscience theory and demonstrate the appropriate analytical, problem solving and clinical reasoning skills is a professional expectation that may not be being met globally for a variety of reasons (Andrew et al., 2015; McVicar et al., 2015). Therefore, facilitating the learning required has become a widely recognised and long standing concern that has been labelled "*the bioscience problem*" (Andrew et al., 2015; McVicar et al., 2015).

Noble, Miller and Heckman (2008) suggest that educational research in nursing may need to focus not on the volume of content learnt, but should detail instead, the mechanisms through which the student learnt the content; for example, what strategies they employed, and if this style of learning was effective. As the demand for highly educated and skilled nurses grows, the need to provide an optimal learning environment becomes an important consideration (Noble et al., 2008). Nurse academics and educators that teach into the undergraduate nursing program may then need to consider the students' learning needs (Noble et al., 2008). Currently, there is limited literature that explores the way in which nursing students learn or process information; namely their learning styles. Furthermore, learning styles have not been considered as a variable that can influence student achievement in the bioscience education of nursing students. Therefore, a literature review was undertaken to explore the barriers encountered to effective teaching and learning, the evidence behind learning styles and the differing evaluative tools and frameworks available.

2.2 THE SEARCH PROTOCOL

An integrative approach was chosen for this review. Integrative research has grown in popularity in healthcare and specifically in nursing, as it recognises the complexity of health care provision, and the value of multiple forms of research on specific topics (Soares et al., 2014). Indeed, research from various epistemological

matrices can contribute to health care provision to benefit patients' health outcome and experience, and to ensure the holistic provision of evidence-based practice (Soares et al., 2014). Furthermore, discussions that include research evidence from various methodologies add strength to the data's interpretation by providing a more comprehensive overview of the issue. In the current literature review, a structured approach to source selection, utilising both a detailed search strategy and the Critical Appraisal Skills Program (CASP) Systematic Review Checklist for reviews that are both quantitative and qualitative, was employed. Data extraction and synthesis was systematically undertaken using inductive thematic analysis.

2.2.1 Literature Review Objectives

The literature review was guided by two research objectives:

1. to identify what characteristics contribute to the bioscience teaching and learning problem and,
2. What are the key learning and teaching theories as they relate to learning styles used in the bioscience education of nursing students.

2.2.2 Search Strategy

The search terms used included: (1) anatomy, (2) biological science, (3) bioscience, (4) biology, (5) education, (6) learning styles, (7) nursing, (8) pathophysiology, (9) physiology, (10) science, (11) study methods, (12) study strategy, and (13) student. Search terms were identified through the research theme and were integrated with the Boolean operators "and" and "or" to create suitable search terms and phrases. Medical subject headings (MeSH) including: nursing [MH]; education [MH]; science [MH]; biological science disciplines [MH]; anatomy [MH]; biology [MH]; pharmacology [MH]; and physiology [MH] were also employed where appropriate.

Relevant studies were found utilising combined search approaches including an electronic database search and manually scanning the references from retrieved studies. The search process utilised several databases, namely CINAHL, Education Resources Information Center (ERIC), Science Direct, Web of Science, and ProQuest for research papers related to the field of nursing bioscience education. For example, the initial online search of the Cumulative Index to Nursing and Allied Healthcare Literature (CINAHL) database aimed to identify literature review

objective one: to explore the various and multifaceted determinants of both learning and achievement in the bioscience education of nursing students. Therefore the search terms and Boolean operators were integrated as follows: “education” and “learning styles” and “nursing” and “pathophysiology or physiology.” Duplicates and studies not relevant to the search topic were removed. Two books were consulted and four websites were accessed for supplementary information.

2.2.3 Inclusion and Exclusion Criteria

Inclusion criteria were applied to refine the search results and to identify significant material. Therefore, literature was sourced from peer-reviewed journals with abstracts, full text and references available. Papers that were excluded were those that were not published in the last fifteen years (01/01/2000-31/12/2015) as this ensured the significance and currency of the results. Furthermore, papers published in a language other than English were excluded to prevent translational and cultural misinterpretations. Integrative reviews place no restriction on the study design therefore the search was not limited by study design.

2.2.4 Determining Relevance

A critical appraisal utilising the CASP (2013) Critical Appraisal Checklist was conducted prior to the papers’ inclusion in the literature review (Table 6.1; Appendix A). A critical appraisal allows the individual researcher to determine the relevance and trustworthiness of a study and therefore, appraise its applicability to their research (CASP, 2013). This tool assists the researcher to focus on the approach and methodology of the identified papers to established validity. The CASP checklist is a gold-standard tool for critical appraisals.

This critical appraisal tool contains ten items. These items are yes or no questions that assist the researcher to determine (1) if the results of the paper are valid; (2) what the results are; and (3) if it is relevant in the context of their study. For example, item one asks the researcher if there was a clear statement of the aims of the research; and considering the goal of the research, why the research is important and its relevance to your topic (CASP, 2013). This tool supports the researcher to critically consider a paper’s validity, results and subsequent significance, and then consequently determine whether or not to include the paper in their research (Krainovich-Miller, Haber, Yost & Jacobs, 2009).

This search process is outlined in detail in Table 2.1 and in a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart (Figure 2.1). For the purpose of this review, bioscience included the detailed topics of pathophysiology, anatomy, physiology, microbiology, pharmacology and organic chemistry. This search strategy resulted in the inclusion of 50 papers.

Table 2.1 *Literature search results*

Search engine	**Search terms**	**# Retrieved**	**# Met inclusion criteria**	**# Relevant for inclusion**
CINAHL	5, 6,7,8,9	33	4	6
CINAHL	1,2,4,5,6	586	91	7
ERIC	4,5,10,11,12	3605	522	7
Science Direct	3,4,5,6,12,13	793	56	7
Web of science	1,2,4,5,6,9	555	204	11
ProQuest	4, 5, 6,7,12,13	161, 657	566	8
Citations from manual search		4	4	4
			Total	50

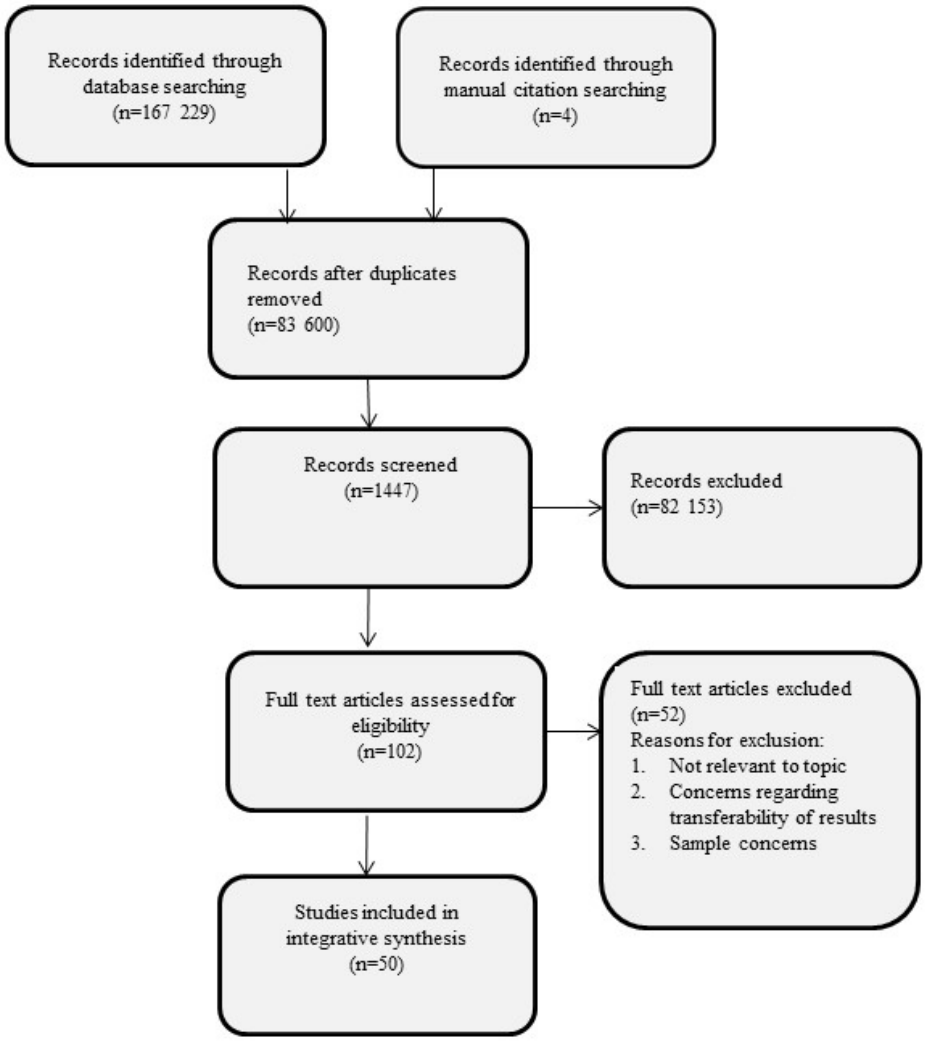


Figure 2.1 PRISMA Flowchart detailing search strategy

2.3 SEARCH RESULTS

Data was extracted from the papers using an inductive approach, which identifies themes in the current research and then generates a new theory based on these inferences. The literature was analysed using the three step thematic analysis process (Appendix B) described by Thomas and Harden (2008). These steps include: (1) coding, (2) organisation of codes into descriptive themes, and (3) the amalgamation of descriptive themes into analytical themes (Table 2.2; Thomas & Harden, 2008).

Table 2.2 *Example of thematic analysis technique*

Literature statement	**Code**	**Descriptive theme**	**Analytical theme**
relevance has not only been questioned by students	RE	Clinical relevance and integration	The Bioscience Teaching and Learning problem
increasing autonomy of nurses make it essential for nurses to have a sound biological knowledge	RN		
rapid change and physiological instability nurses need to draw on bioscience-based knowledge	RP		
lack foundational knowledge	DD	Demographic Diversity	
time constraints	TD		
lack confidence	ED		
Language and terminology difficult	LD		
academic aptitude	AD		
English language proficiency	CD		

Note: RE=Relevence to Education, RN= Relevance to Nursing, RP=Relevance to Practice, DD=Demographic Diversity, TD=Time Issue Due To Diversity, ED= Emotive Diversity, LD=Language Diversity, AD=Academic Diversity, CD=Cultural Diversity.

This process resulted in two analytical themes: (1) the bioscience teaching and learning problem, and (2) underpinning teaching and learning theories. The two analytical themes and the subsequent descriptive themes that were evident in the literature are summarised in Table 2.3. These descriptive themes answer the review objectives and directly contribute to the development of a conceptual model that will aide nursing bioscience educators to consider the interactions of these determinants within their teaching (Figure 2.4).

Table 2.3 *Summary of themes present in the literature*

Analytical Theme	Descriptive themes
The Bioscience Teaching and Learning Problem	1. Clinical relevance and integration 2. Demographic diversity 3. Facilitating learning 4. Teaching methods
Underpinning Teaching and Learning Theories	1. Learning style theories 2. Integrating learning styles knowledge 3. Learning style frameworks

2.4 ANALYTICAL THEME 1: THE BIOSCIENCE TEACHING AND LEARNING PROBLEM

Analytical theme one answers review objective one in that it identifies the characteristics that contribute to the bioscience teaching and learning problem. It explores four descriptive themes derived from the literature that identify the characteristics that contribute to the bioscience teaching and learning problem experienced by nursing students in their bioscience education. For example, descriptive theme one and two focus on the student needs in that descriptive theme one; details the relevance and integration of bioscience within nursing practice, while descriptive theme two delineates demographic and diversity considerations. Descriptive themes three and four relate more to the teacher and their approach; descriptive theme three discusses how learning is facilitated and last, descriptive theme four debates the various teaching methods employed.

2.4.1 Descriptive Theme 1: Clinical Relevance and Integration

Descriptive theme one discusses the research by Smales (2010), Davis (2010), Andrew, McVicar et al. (2015), Birks Cant, Al-Motlaq and Jones (2011), Whyte Madigan and Drinkwater (2011) and Wu, Tham, ST, Tan-toh, Tan (2010).

Bioscience and pathophysiology concepts are arguably a cornerstone of nursing practice. Smales (2010) proposed that it is only with a comprehensive

knowledge of the biosciences that nurses are able to correctly interpret changes in the patients' physical condition, and apply the appropriate corresponding interventions. This knowledge comprehension and subsequent application may present a challenge when nursing students report experiencing difficulties in the amalgamation and integration of bioscience education with clinical situations (Smales, 2010).

Smales (2010) suggests that without a comprehensive understanding of the biosciences, nurses may be unable to recognise detrimental changes in their patients' physiological observations. This ignorance may adversely affect patients' health outcomes. Smales (2010) further suggests that an appreciation of bioscience may improve nurses' practice and efficacy in the delivery of nursing care. Therefore Smales (2010) emphasises the relevance of bioscience to the practice environment within the nursing profession.

Davis (2010) suggests that there is a professional expectation that nursing students grasp bioscience knowledge and are able to apply the commensurate skill to address changes in their patients' condition. Indeed, this expectation is expressed within the Registered Nurse Standards for Practice (2016) which states that that the Registered Nurse will "use assessment data and best available evidence to develop a plan" of nursing care. Despite this expectation Davis (2010) suggests that nurses found within their nursing program a lack of integration between bioscience theory and clinical practice. Indeed, this lack of integration led to nurses reporting difficulty in applying bioscience knowledge to a range of clinical practice contexts (Davis, 2010). All participants in the study by Davis (2010) described a lack of linkage between bioscience and the role of the nurse within practice settings. This led to nurses feeling inadequately prepared for the realities of their role (Davis, 2010). Therefore, understanding the relevance of bioscience to clinical practice is integral to the nursing students' ability to integrate and apply this knowledge to their practice (Andrew et al., 2015).

Andrew et al. (2015) suggests that students may associate the relevance of bioscience with their perceived view of its usefulness within clinical practice. Therefore, if a student is unable to understand the relevance of bioscience material to clinical practice, they may inappropriately assume irrelevance (Andrew et al., 2015). Andrew et al. (2015) and Davis (2010) found that engagement with clinical practice concepts is imperative to reinforce the relevance of bioscience in practice, and to

form associations between the content provided. Indeed, Andrew et al., (2015) emphasise the importance of interdisciplinary collaboration to ensure the integration of bioscience and nursing concepts. McVicar et al. (2015) and Birks et al. (2011) suggest that students who possess a strong understanding of bioscience and how the concepts underpin their clinical practice may transition into Registered Nurses that are confident in applying this knowledge.

Andrew et al. (2015) and Whyte, Madigan and Drinkwater (2011) suggest that nurses require knowledge of the multidirectional interactions between body systems, disease processes, pharmacological effects and the nursing care they provide, due to the causal relationship these factors have on patient outcomes. For example, the pathophysiological changes that occur in patients with chronic renal failure result in the retention of fluid. This fluid retention increases the patients' blood volume and consequently their blood pressure. This action increases the cardiac workload and places strain on the heart muscle (Craft et al., 2015). Therefore, facilitating an understanding of the relevance of bioscience within nursing appears vital to students' integration of the content within clinical practice. Indeed, Whyte et al. (2011) suggest that as nursing students gain more of an understanding of the role and responsibilities of the nurse they develop a greater appreciation for bioscience units.

Thus, Registered Nurses have many roles and responsibilities in the diverse clinical situations they encounter. Their scope of practice is immense, and with higher patient acuity, the need for critical thinking skills and an integrated approach to transferring fundamental classroom knowledge to practice is essential (Wu, Tham, ST, Tan-toh, & Tan, 2010).

2.4.2 Descriptive Theme 2: Demographic Diversity

Descriptive theme two discusses the research by Koch, Everett, Phillips & Davidson (2014), Efstathiou and Bailey (2012), Colville, Cottom, Robinette, Wald and Waters (2015), Craft et al. (2013), Bhatti and Bart (2013), McVicar et al. (2014), McVicar et al. (2015), Joy and Kolb (2009), Fogg, Carlson-Sabeli, Carlson and Giddens (2013), Tabi, Thornton, Garno and Rushing (2013), Amaro, Abriam-Yago and Yoder, (2006), and Miller (2010).

The composition of the nursing profession in Australia has endured a period of significant evolution and growth. Previously a profession comprised of young

women, it is now diverse and heterogeneous in both gender and educational pathway (Koch et al., 2014). Australia has many ethnic and cultural identities, and government policy accommodates various cultural groups. Indeed, multiple political schemes are employed to broaden the multiculturalism and diversity in universities (Koch et al., 2014). Moreover, Efstathiou and Bailey (2012) suggest that due to the large number of skilled nurses approaching retirement, universities have increased their student numbers and lowered course entry expectations. The aim of these changes is to encourage student entry into the Bachelor of Nursing program and therefore combat the expected global nurse shortage (Estathiou & Bailey, 2012). This multiculturalism and diversity has created a diverse student learning environment (Koch et al., 2014). As there are significant benefits to a diverse nursing workforce discussion on the influence of individual student characteristics such as age, gender, and English language proficiency on both learning and achievement is essential (Colville et al., 2015). Craft et al. (2013) found that nursing students reported finding bioscience difficult to learn ($p=0.02$) and that students experience of anxiety surrounding bioscience education increased with the students age ($p=0.00$). Koch et al. (2014) found mature aged students were often thought to have knowledge and experience beyond their level of learning based on their life experience and as such, they may feel increased academic pressure and may discuss variations in their student experience. Furthermore, Bhatti and Bart (2013) found a statistically significant difference ($p=0.014$) between the academic achievement of male and female students, with female students scoring higher mean results (3.034) than male (3.145) on a 4.0 scale. These results appear to suggest that student characteristics influence their achievement.

These individual characteristics that influence bioscience learning may include previous exposure to and learning of biosciences from secondary or vocational education providers and healthcare industry exposure (Craft et al., 2013; McVicar et al., 2014). Indeed, Craft et al. (2013) identified that students found prior learning in bioscience advantageous to their nursing education ($p=0.01$). Subsequently, McVicar et al. (2015) suggested that admissions criteria for nursing programs should include prior learning in bioscience as students in their review had found difficulty with the unfamiliar concepts and terminology. Indeed, Efstathiou and Bailey (2012) found nursing students that have no nursing exposure or scientific background may

consequently experience difficulties learning the bioscience content (Efstathiou & Bailey, 2012).

Joy and Kolb (2009) and Koch et al. (2014) suggest that differences in age, gender, and social and cultural groups are determinants of the student experience and their educational achievement. For example, Joy and Kolb (2009) suggest there is a tendency for Taiwanese students to be more reflective and conservative in their learning whereas American students tended to be more active and individualistic. This finding may suggest that culture and ethnicity are an important consideration in student learning. Indeed, Fogg, Carlson-Sabeli, Carlson and Giddens (2013) found that ethnicity influences learning styles and that there were differences in learning between African American (Assimilators p=0.001) Asian American (Divergers p=0.000) Caucasian (Convergers- p=0.004) and those from Hispanic/Latino (Accommodators p=0.006) backgrounds. The findings within these studies (Fogg et al., 2013; Joy and Kolb, 2009; Koch et al., 2014) suggest that culture and ethnicity are important determinants of student learning and achievement.

Tabi, Thornton, Garno and Rushing (2013) continue the discussion suggesting that while diversity is increasing, men, mature age, racial and ethnic groups in particular may experience additional difficulties. They found that the student experience of these groups may be clouded by feelings of loneliness, and isolation (Tabi et al., 2013). Tabi et al. (2013) continue by suggesting that these students experience additional academic and financial pressures as they manage competing interests and demands including complex personal time constraints and the need to generate an income. Indeed, financial pressures such as child care, housing, internet, travel, living expenses and academic needs such as tutoring, and text books, have been identified as barriers to effective learning, and nursing student success (Amaro, Abriam-Yago & Yoder, 2006).

Additionally, Miller (2010) suggests that English language proficiency has been identified as a major determinant of achievement in the bioscience education of nurses, as students describe bioscience as possessing its own language. Koch et al. (2014) suggest that this creates difficulty for students not proficient in English or with English as a second language. These students may have difficulty understanding technical terms in conversations between the numerous and varied health professionals, and in understanding the Australian colloquial expressions often used

in the health care setting (Craft et al., 2013; Koch et al., 2014). These individual characteristics may contribute to nursing students reported difficulties in learning bioscience. Consequently, Koch et al. (2014) suggest that nursing students perceive their pathophysiology knowledge to be weak when encountering complex clinical situations.

2.4.3 Descriptive Theme 3: Facilitating Learning

Descriptive theme three discusses research by Craft et al. (2013), Christensen et al. (2015), Davis (2010), and Smales (2010).

The current debate surrounding who may be the most appropriate and adequately qualified educator to facilitate the learning of bioscience to nursing students requires consideration. Bioscience education in Australia is predominantly delivered in universities by biomedical scientists or pathophysiologists who have little or no nursing experience, clinical nursing background or understanding of the expectations or the roles and responsibilities of the modern Registered Nurse (Davis, 2010). The education of students from a scientific perspective instead of a nursing viewpoint may have led to nursing students experiencing difficulty relating this theory to practical situations (Craft et al., 2013). For example, nursing students may not be able to relate cellular biomechanics and physiology, such as glial cell function at a microscopic level, to what this means for the patient holistically unless direct links are made by lecturers. Therefore, bioscience educators may not be able to appropriately facilitate education if they are unable to provide contemporary clinical examples of the concepts and demonstrate clinical relevance within the scope of nursing (Craft et al., 2013).

Despite this lack of appropriate context, Christensen et al. (2015) found that student nurses value the depth of knowledge provided by a bioscientist. Christensen et al. (2015) found in their quantitative study that 90% of nursing students found the knowledge provided by a bioscientist assisted students to gain an understanding of disease processes. Yet nursing students still appeared to require nursing input to contextualise the bioscience theory, and understand what this theory may indicate in terms of the treatment they provide (Christensen et al., 2015). Their study indicated that a nursing context is essential for nursing students to apply this knowledge within practice (Christensen et al., 2015). Davis (2010) suggests that bioscience needs to be applicable to nursing studies and should be related to nursing practice therefore

supporting the experiential foundation of nursing education. Davis (2010) emphasised the role of bioscience educators in assisting students to apply theoretical bioscience concepts to clinical practice.

A further concern acknowledged by Davis (2010) and Smales (2010) is the apparent lack of consensus on appropriate concepts and depth of biological science knowledge required for the nursing profession. Therefore, there may be variations in the content and teaching practice between lecturers and institutions both domestically and internationally (Davis, 2010). Indeed, Davis (2010) suggests this variability may be compounded by the lack of specific detail in the current frameworks providing guidance on the bioscience knowledge required; these are predominantly competency based. For example, in Australia, the Australian Nursing and Midwifery Accreditation Council (ANMAC) (2012, p. 13) has stated in standard 3.4 that the institution provides "*curriculum content and the rationale for its extent, depth and sequencing in relation to the knowledge, skills and behaviours expected of students at each stage of the program."* This statement is open to various subjective interpretations and therefore provides little detail on the level of knowledge required both of the Registered Nurse and the nursing student throughout the nursing program specifically in relation to bioscience.

Smales (2010) poses concerns over the teaching of clinical practice techniques by nurse facilitators and nurses already in practice. These educators may not possess adequate knowledge of, or encourage students to understand, the intrinsic and multidirectional links between bioscience and the interventions delivered for patient care (Smales, 2010). The facilitation and education of nursing students in the clinical environment is detailed in the Registered Nurse Standards for Practice; NS 4.2 "*Contributes to the professional development of others…including nursing students…to meet their learning objectives* (NMBA, 2016, p.5)." Therefore the education of nursing students is largely dependent on the ability of Registered Nurses and facilitators in practice to teach bioscience and emphasise its transferability and relevance to clinical practice.

2.4.4 Descriptive Theme 4: Teaching Methods

Descriptive theme four discusses research by Smales (2010), Craft et al., (2013), McVicar et al. (2010), Efstathiou and Bailey (2012), Meehan-Andrews

(2009) Sinclair and Ferguson (2009), McVicar et al. (2014), Taylor, Ashelford, Fell and Goacher (2015), Davis (2010) and Bakon et al. (2015).

The teaching and assessment methods employed by bioscience educatorsmay affect the ability of students to learn and apply bioscience knowledge when there are inconsistencies in the educational delivery modes utilised between different lecturers and institutions (Smales, 2010). Therefore, the difficulties students experience in learning bioscience may be compounded by a combination of teaching methodology issues (Craft et al., 2013; McVicar et al., 2010). These include concerns with the learning environment, content delivery style, curriculum time, and inadequate assessment modes (Craft et al., 2013; McVicar et al., 2010).

Regarding content delivery style, nursing students are conventionally taught bioscience concepts through the mode of a lecture series combined with tutorials or laboratory workshops, and in some cases through online web-based materials. These methods permit the dissemination of a large volume of content but position the students as passive receivers of knowledge (Efstathiou & Bailey, 2012). Lectures fail to take into account active learning principles and students' differing learning styles or study modalities. Furthermore, the student can experience stress from information overload (Efstathiou & Bailey, 2012; Meehan-Andrews, 2009; Sinclair & Ferguson, 2009). Indeed, Efstathiou and Bailey (2012) have criticised lectures as outdated due to their time length and the lack of actual information exchange occurring, as students may only be able to concentrate for short periods at a time. Therefore, despite educators favouring this didactic and economical approach, lectures may be a poor choice for content delivery that compromise student learning (McVicar et al., 2014; Meehan-Andrews, 2009).

Meehan-Andrews (2009) and Taylor, Ashelford, Fell and Goacher (2015) suggest that nursing students, particularly in their first year of nursing study where most bioscience subjects are taught, lack experience with the tertiary learning process. This lack of experience with the tertiary learning process may be due to inadequate secondary schooling preparation or the changing dynamic of the student cohort. Universities within Australia are facilitating the entry of larger numbers of mature aged, first in family and alternate entry pathway students which may not have previously engaged in higher education. Nursing students have felt that there is an inadequate amount of time allocated during semester for them to effectively learn

and apply the complex and content heavy concepts contained in the bioscience units (Meehan-Andrews, 2009; Taylor et al., 2015). This finding was echoed by Davis (2010) who suggested that new graduates felt that there was not enough time devoted in the nursing curriculum to the study of bioscience, and that material wasn't taught sufficiently due to time restrictions.

Additionally, Davis (2010) found that new nursing graduates felt that the bioscience curriculum did not meet their needs in relation to the clinical requirements of the nursing role. Their research indicated that the bioscience content was not sufficiently linked to their role, and that there was a lack of integration between the bioscience and nursing concepts (Davis, 2010). This lack of adequate pre-registration grounding may have arisen from a lack of collaboration between nursing academics and bioscience educators and consequently a lack of assimilation between bioscience and the nursing curriculum. The lack of integration and assimilation may lead to a Registered Nurse who is deficient in knowledge, lacking the ability to identify knowledge gaps and unable to transfer knowledge between the educational and clinical environments (Davis, 2010). An inadequate curriculum perpetuates a cycle where Registered Nurses are unable to facilitate the continuing education and integration of bioscience theory into practice for nursing students on clinical placement (Davis, 2010).

Taylor et al. (2015) suggests that the type of assessment employed, whether formative or summative, should facilitate and encourage learning, yet this view of assessment as a method to continue learning instead of a method to rank student achievement appears to be met with resistance and may be functionally difficult to execute. For example, academics may have difficulties in designing innovative assessment items that encourage learning and therefore resort to traditional assessment methods such as multiple choice questions. Multiple choice questions are a popular choice of assessing mode in bioscience units due to their marking convenience, but have been criticised due to their inability to foster a comprehensive understanding of the content, an inability to assess critical thinking skills and knowledge application, synthesis and interpretation (Smales, 2010; Taylor et al, 2015). Assessments can support student learning by being congruent with the content and employing active learning principles (Bakon et al., 2015) Assessment that employs active learning principles may prove to align with the experiential learning

process and enhance nursing student learning. The ability to interpret, integrate and apply bioscience knowledge is a considerable concern, and therefore this lack of emphasis on the provision of appropriate assessment contributes to the theory-practice deficit.

2.5 Analytical Theme 2: Underpinning Teaching and Learning Theories

Analytical theme two answers review objective two in that it identifies key learning and teaching theories as they relate to learning styles used in the bioscience education of nursing students. It explores four descriptive themes that discuss the influence of teaching and learning theory on nursing bioscience education. For example, descriptive theme one and two focus on the student needs; descriptive theme one details learning style theories and their conceptual background. This is followed by descriptive theme two discuss the integration of learning style theory into andragogy and finally descriptive theme three which delineates the different learning style frameworksavailable.

2.5.1 Descriptive Theme 1: Learning Style Theories

Descriptive theme one discusses research by Cegielski, Hazen and Rainer (2011), Béres, Magyar and Turcsányi-Szabó (2012), Biggs (2012), Roth and Lee (2007), Blevins (2014), Searson and Dunn (2001), Charlesworth (2008), James, D'Amore and Thomas (2011), Romanelli, Bird and Ryan (2009), Felder and Brent (2005), Fleming, McKee and Huntley-Moore (2011), Andreou, Papastavrou & Merkouris (2014), Wu et al. (2010) and Li, Yu, Liu, Shieh and Yang (2014).

Cegielski et al. (2011) suggest that learning styles or, more broadly, the way in which individuals learn, is formed by an individual's preconceptions, personality, past experiences and cognitive processes. Indeed, cognitive processes are usually described as individual traits that influence values, attitudes and interactions (Béres et al., 2012). Learning styles evolved from this premise, and are believed to be the manifestation of various cognitive facets and environmental elements that influence the cognitive learning process (Béres et al., 2012). Biggs (2012) suggests that the learning process is a method of interacting with the world, and as an individual internalise new knowledge into their existing cognitive matrix, they reorganise the information and use it to build a new conceptual understanding. Indeed this view, that that learning cannot be separated from the personal interests, inclinations and life

experiences of the learner conforms to the social constructivist view theorised by Vygotsky (1896-1934). Vygotsky posited that learning is not fixed, but is influenced by the social and cultural characteristics and experiences of the learner (Cited in Roth & Lee, 2007). It therefore follows that one of the most enduring concepts in educational literature emerging from this social constructivist view is that individual differences are an explanation for, and may predict, variations in student success, and that andragogic methods such as the various learning style models can therefore, be developed to capitalise on these differences (Béres et al., 2012; Blevins, 2014).

Learning style theories assume numerous tenets about the learning process including: (1) individuals can learn, (2) individuals respond differently to various instructional methods, resources and approaches, (3) that individuals have different strengths, (4) instructional preference of learning styles can be reliably measured, (5) students may engage more within a specific learning environment, (6) educators can use this knowledge as a cornerstone to their teaching strategy, and (7) students can capitalise on their learning style preference when assimilating new information (Searson & Dunn, 2001).

Learning style teaching models emerged from the premise that individuals' cognitive function in relation to the way they concentrate, process and remember new information is different (Béres et al., 2012; Blevins, 2014; Searson & Dunn, 2001). These differences are based on their development and personal characteristics, which may make various forms of educational instruction effective for some and ineffective for others (Béres et al., 2012; Blevins, 2014; Searson & Dunn, 2001). Therefore, Charlesworth (2008) posits that if it is accepted that culture is a non-homogenous variable where there may be a commonality of beliefs and actions, then it has to be accepted that certain groups may possess a distinct framework they employ in their learning and study methodology. Thus, individual characteristics such as culture may influence the method a group of individuals predominantly employ to learn.

The many differing definitions of learning styles have led to ambiguity regarding their impact on student success (James et al., 2011; Romanelli et al., 2009). Consequently, the concept of learning styles is not consistent in all fields of research. As such, there are many popular conceptualisations of learning style which are not uniformly endorsed across differing specialisations (Felder & Brent, 2005). The

controversy can largely be attributed to the various definitions, interpretations, questionnaires and inventories available, and the background or perspectives from which they have been developed such as psychology and education (Fleming et al., 2011). These definitions include: that learning styles are the method through which an individual learns best; that they are a psychological manifestation of the learning environment in which the student is immersed; that learning styles incorporate cognitive psychosocial demographics; and that they reflect habitual behavioural preferences within learning environments (Andreou et al., 2014; James et al., 2011). Wu et al. (2010) adds another element suggesting that learning styles may also be defined as the environmental conditions under which a student will learn information.

Learning styles can further be described as the way in which students acquire and comprehend information (Li et al., 2014). Li et al., (2014) observed that there is evidence to supporting the notion that each student will have a favoured method to assist them with processing and recall of the content that is a requirement for them to learn. Thus, in considering the various schools of thought, the definition employed for the purpose of this study was summarised by James et al. (2011) who suggested that learning styles could be described as the habitual method of learning by study or experience. This definition whilst broad in nature yet conforms to the underlying accepted tenants within learning style theories.

2.5.2 Descriptive Theme 2: Integrating Learning Styles Knowledge

Descriptive theme two discusses research by Cegielski et al., (2011), Hung (2012) Tinajero et al. (2012) Fogg et al. (2013), Wu et al. (2010), Kyprianidou, Demetriadis, Tsiatsos and Pombortsis (2012), Charlesworth (2008), Bhatti and Bart (2013) Li, Chen and Tsai (2008), Romanelli, Bird and Ryan (2009), Threeton, Walter and Evanoski (2013), McCrow Yevchak and Lewis (2014), Koch et al. (2014), McKinnon (2009) Li et al. (2014), Avillion (2009), and Hallin (2014).

The many cognitive, cultural, individual and environmental student determinants present in the multicultural tertiary education environment may influence the development of a nursing student's individual learning styles (Cegielski et al., 2011; Hung, 2012; Tinajero et al., 2012). Therefore, these various student characteristics amalgamate into the perspective that student learning methods or learning styles are an integral concept for educators to consider for conveyance of

content in a mode that is both effective, and conducive to the erudition of a diverse student populace (Fogg et al., 2013). There is currently limited research on learning styles in the field of nursing; this represents a substantial gap in the literature. The learning styles that nursing students employ in their learning of bioscience concepts is an important consideration for educators, due to the plethora of teaching and learning problems associated with the appropriate acquisition and application of bioscience content within a nursing context. Thus, as nursing practice incorporates many interrelated disciplines in the provision of healthcare such as law, research, information technology and psychology, it is therefore acceptable to draw from the varied educational research in these fields.

In the education sector for example, it has been debated whether or not learning styles is an important characteristic in the aggregation of various educational pathways (Cegielski et al., 2011; Hung, 2012). Wu et al. (2010) suggest that if a student is aware of their preferred styles, they may be able to capitalise on the knowledge employing it to their advantage and become more confident and aware of their own educational assets and flaws.

The main debate appears to be the argument over the need for congruency in teaching and learning modalities; which has been a prevailing theme debated since the concept's inception (Kyprianidou et al., 2012). Within the education sector, it is heavily debated whether students may acquire an increased understanding of the required content when the teaching approach is congruent with student learning style modalities (Cegielski et al., 2011). However, the notion of learning styles resonates with many nursing academics in that it provides an avenue through which educators can cater to diverse cohorts such those seen within as nursing, and recognises that a one-size fits all approach to teaching may not be the most effective method through which to promote learning (Hung, 2012). For example, Charlesworth (2008) found when employing the Honey and Mumfords Learning Style Inventory there were moderate differences between learning style preferences between Indonesian, Chinese and French students (Activist f=0.30 Reflector f=0.33, Pragmatist f=0.24, Theorist was not employed by these participants) when analysed using Cohen's *F*. These results may indicate that learning style is influenced by culture and therefore inherent differences between students may influence their learning.

There is evidence, supporting and dismissing, the ideal of matching teaching and learning styles in the didactic teacher-student relationship (Hung 2012; Kyprianidou et al., 2012). Consequently, learning style assumptions have been heavily critiqued in the education industry (Cegielski et al., 2011). Li, Chen and Tsai, (2008) support the assertion that through learning styles identification, a student's preference for specific learning methods may be identified, and teaching can be catered for the students' needs, which may then influence their achievement. Cegielski et al. (2011) discusses an arguable increased educational satisfaction and a more rapid rate of comprehension of the content matter when the andragogical approach is aligned with the students' learning styles. They found a statistically significant improvement in student outcomes when visual learners were taught with visual based instruction ($p=<0.001$), yet no statistical difference was noted for aural learners ($p=0.413$) (Cegielski et al., 2011). Bhatti and Bart (2013) and Hung (2012) suggest there is substantial research demonstrating a positive correlation for the assertion that when andragogy is synchronous with learning style, improved performance may be noted. Specifically, Bhatti & Bart (2013) found that learning style within social sciences was a statistically significant determinant ($p=0.036$) of academic achievement. Thus, it may be concluded from educational studies that despite the conjecture, the imbalance and fragmentation of research, there is support for and a positive relationship between teaching and learning methods; when they are synchronous the outcome may be an improvement in academic performance (Cegielski et al., 2011: Hung, 2013; Threeton et al., 2013).

McCrow et al. (2014) found that Registered Nurses learnt more effectively if the mode through which education is provided correlated with their learning styles, which within their study was active-reflective. However, this assertion appears to have not been established with the nursing student. This may be due to the ambiguity regarding learning styles definition, or the debate regarding matching teaching and learning styles currently observed in other fields (James et al., 2011; Romanelli et al., 2009). However, there is significant ongoing support and merit for investigations into the influence of learning styles within tertiary education to empirically ascertain a correlation between styles and academic achievement (McCrow et al., 2014).

The learning style concept has been generally accepted as an impacting factor that considers the interplay of personal and contextual aspects on student education,

and therefore has been largely incorporated into education literature (Kyprianidou et al., 2012; Threeton et al., 2013). Threeton et al. (2013) added to the educational debate by proposing that through learning styles or study strategy identification, adaptive teaching strategies could be developed to meet the learning needs of students. Indeed, learning styles identification may assist educators in making learning design choices to enhance the learning experience (Koch et al., 2014). For example effective teaching plans that may be developed that increase students' academic confidence, provide students with effective studying techniques, and maintain or decrease attrition rates (Koch et al., 2014). Learning style identification may assist academics to facilitate an understanding of the intrinsic relationship between learnt theory and nursing practice and therefore students may integrate and appropriately utilise bioscience course content (Koch et al., 2014). Li, Chen and Tsai (2008) concluded in their evaluation of nursing learning styles that nursing academics can modify modes of delivery, engagement and assessment, and develop teaching methods to enhance learning. This approach, namely evaluating strategies that meet students learning needs, has not been applied specifically to the bioscience education of nurses; thus the learning styles employed by nursing students in bioscience are unknown despite having been shown to be useful in clinical nursing practice.

Research by McKinnon (2009) and Li et al. (2014) suggest that the student experience may not have always been taken into account in the development of content delivery methods. Not considering the students' experience of learning may have led to student failure and a lack of emphasis placed on andragogy. Li et al. (2014) recommends that a more comprehensive understanding of the mechanisms through which learning styles influence bioscience education may be beneficial. For that reason, Avillion (2009) continues to suggest that for nursing educators to formulate teaching plans that positively influence student performance, they need to understand their students' learning styles preferences. Indeed, universities as a provider of nursing education are required to offer, as delineated in Accreditation Standard 8.3 "*experiential learning of curriculum content that is progressively linked to attaining the current National Registered Nurse Standards for Practice (ANMAC, 2012, p.18).*" Therefore understanding the student experience, student learning processes and the factors that influence student achievement such as specific cohort

characteristics, within a discipline of learning is essential for education provision (Hallin, 2014).

2.5.3 Descriptive Theme 3: Learning Styles Frameworks

Descriptive theme three discusses research by Béres et al. (2012), McCrow et al. (2014), VARK (2016), James et al. (2011), Alkhasawneh, Mrayyan, and Docherty, Alashram and Yousef (2008) Meehan-Andrews (2009), The Myer-Briggs Foundation (2016), Holtbrugge and Mohr (2010), Wilkinson, Boohan and Stevenson (2014), Alkella (2010), Flemming et al. (2011), Kappe, Boekholt, den Rooyen & van der Flier (2009), Mayfield (2012), McKinnon (2009) Avillion (2009), Li et al., (2014), Fogg et al. (2013) and Hallin (2014).

There are over 71 different learning style models, many of which employ a quadrant or four preference approach in their assignment of learning styles. Some of the more popular models include the Visual Aural Read/write Kineasthetic (VARK) modalities, the Myers-Briggs Type Indicator (MBTI), Kolbs Experimental Learning Cycle, and Honey and Mumford's Learning Style Inventory (LSI) (Béres et al., 2012). Numerous instruments have been developed from these models to evaluate student information and to specifically determine a students' preference for individual learning styles (McCrow et al., 2014). These include the VARK Questionnaire, the MBTI, and Honey and Mumford's LSI which was based on and developed from Kolbs Experimental Learning Cycle (McCrow et al., 2014).

The VARK Modalities suggest that there are four learning styles, namely Visual, Aural, Read/Write and Kinaesthetic that may overlap creating a multimodal learner (VARK, 2016). The corresponding questionnaire aims to determine the way in which individuals prefer information to be delivered (VARK, 2016). In this way, VARK limits its applicability to the determination of modal preferences, as its questionnaire identifies ways that participants favour information delivery with little discussion on its psychometric properties (VARK, 2016). Despite this limitation, the VARK Questionnaire is one of the simplest and most convenient learning style questionnaires that can be used for andragogical purposes. It has been utilised in the field of nursing education for individual student knowledge on learning styles preference (James et al., 2011).

The VARK Questionnaire requires students to complete an online questionnaire, then to self-report their identified learning styles to the researcher (VARK, 2016). Results generated from the VARK Questionnaire can only be obtained through manual input of the participant responses into the VARK website furthering the agenda and research on the model. This method may cast doubt on the validity of findings. Furthermore, the VARK Questionnaire presents various challenges in its applicability to research due to stringent copyright regulations and a lack of algorithm detail. The method through which learning styles are determined are not detailed or publicised, therefore there is a lack of transparency within this tool and its theory (Alkhasawneh et al., 2008; Meehan-Andrews, 2009; James et al., 2011).

The MBTI is based on the assumption that there are basic differences in the way that individuals use their perception and judgment, and that this is built upon a personality preference (The Myer-Briggs Foundation, 2016). The MBTI contains four dimensions of learning: (1) preference to focus attention (extraversion or introversion), (2) preference to absorb and process (sensing and intuition), (3) preference to prioritise (thinking and feeling) and (4) preference of style (judging and perceiving) (Béres et al., 2012). This learning style model and corresponding inventory can result in sixteen different learning styles (Béres et al., 2012). However, it has been suggested that the MBTI tool cannot be used with confidence due to a lack of published data to establish its validity and reliability (Alkhasawneh et al., 2008).

Kolb's Experimental Learning Cycle is developed from the assumption that individual learning patterns can be conceptualised into a circular process or cycle (Holtbrugge & Mohr, 2010). It describes four stages of learning, including concrete experiences, reflective observations, abstract conceptualisation and active experimentation (Holtbrugge & Mohr, 2010; Wilkinson et al., 2014). The cycle proposes that learning commences with a concrete experience, where the learner is actively engaged in an experience (Holtbrugge & Mohr, 2010). This leads into the subsequent stage of reflective observation, in which the student considers and plans methods of response to the concrete experience (Alkella, 2010; Holtbrugge & Mohr, 2010). The student then understands the experience and devises integrated models to address identified concerns during the stage of abstract conceptualisation (Alkella,

2010; Holtbrugge & Mohr, 2010). Abstract conceptualisation then concludes when a decision is made, which is then enacted in the stage of active experimentation which completes the cycle (Alkella, 2010; Holtbrugge & Mohr, 2010). In Kolb's corresponding learning style questionnaire, learners are classified as Convergers, Divergers, Assimilators or Accommodators. Convergers learn through deductive reasoning, Divergers utilise various perspectives to generate results, Assimilators use inductive reasoning, and Accommodators utilise experimentation (Béres et al., 2012).

Alkella (2010) suggests that Kolb's model stimulates students and challenges them to develop necessary skills for effective thinking and problem solving. This model quickly gave way to the more popular and user friendly Honey and Mumford's Learner Typology. This is of specific importance in nursing education, as students need to develop metacognitive skills that enable them to think critically and consequently intervene when necessary to improve the health outcomes for their patients. The Honey and Mumford's Learner Typology possesses a detailed theoretical framework that was derived from and built on Kolb's Experimental Learning Cycle (Wilkinson et al., 2014) and at its core was the notion of experiential learning. In particular Wilkinson et al. (2014) describe the four stages as experiencing, reviewing the experience, drawing conclusions from the experience and planning the next action. Honey and Mumford's Learner Typology identifies four learning styles, each aligned with a specific stage of Kolb's Experimental Learning Cycle: Activists, Reflectors, Theorists and Pragmatists (Wilkinson et al., 2014). The emphasis placed upon the practical experience within Kolbs cycle and the subsequent Honey and Mumford's typology is a defining feature of this learning style theory that makes it uniquely applicable to nursing education. The interaction of these two theories is detailed in Figure 2.2.

Nursing education within the university setting recognises the experiential nature of nursing practice and therefore structures its education accordingly. For example, significant allotments of learning are completed within the practice environment to facilitate experiential learning.

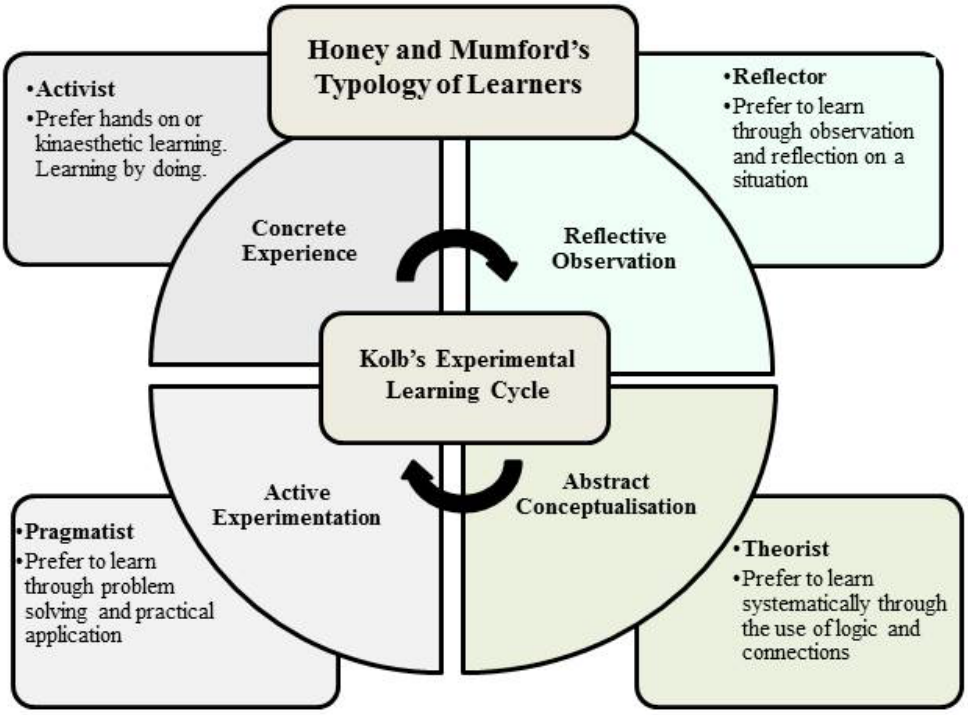


Figure 2.2 Integration of Kolb's Experimental Learners Cycle and Honey and Mumford's Typology of Learners

Honey and Mumford's Learner Typology is flexible and has the advantage in that it concedes that style changes depending on the concepts taught (Fleming et al., 2011). Therefore, the Honey and Mumford's Learning Style Inventory (LSI) was developed to classify a student's preference for a learning style, recognising that learning style is not a fixed feature, and that each individual will utilise all learning styles in some aspects (Wilkinson et al., 2014). In this way, Honey and Mumford's theory suggests that students can become well rounded learners if they are aware of their dominant learning style and actively develop the styles that are underutilised (Fleming et al., 2011). Honey and Mumford's LSI delineates the different attributes of its identified learning styles; for example, Activist learning is intuitive, and does not adhere to structure, or procedural teaching, whereas Theorists thrive on systems and logic (Béres et al., 2012; Kappe et al., 2009). Pragmatists learn through debate and discussion which contrasts with Reflectors who learn utilising scientific methodology including observing and experimenting (Béres et al., 2012; Kappe et al., 2009). Kappe et al. (2009) determined that Honey and Mumford's LSI displays predictive validity, stability, consistency and reliability which will be discussed in section 3.6.3.

Honey and Mumford's LSI has been described as a comprehensive multidimensional instructional tool that may assist in guiding teaching to become more engaging and interactive because of its experiential nature (Hallin, 2014). Indeed, Mayfield (2012) conducted a small pilot study educating students on learning style theories and requiring nursing students to use multiple learning style inventories to identify their learning styles. The focus of Mayfield's study (2012) was on how nursing students used learning style knowledge, not what style or model they predominantly identified with. In this study, Mayfield (2012) found that students were capitalising on their learning style knowledge for continual content reinforcement throughout their degree. Moreover, Mayfield (2012) suggested that when students believed that their education was matched to their learning styles, they were able to retain information more effectively. Despite this conclusion, no study to date has explored matching teaching strategy with nursing student learning styles within the bioscience units. Furthermore, the literature suggests that learning styles are fluid and students whilst having a dominant preference, may adapt their learning between subjects (Fleming et al., 2011). Therefore, the learning styles employed in the bioscience units may differ from the practical based nursing units (Fleming et al., 2011).

2.6 SUMMARY

From the literature, two analytical themes and several descriptive themes were identified. These included the bioscience teaching and learning problem and the underpinning teaching and learning theories. The relationship between these themes and subthemes can be clearly seen in Figure 2.3.

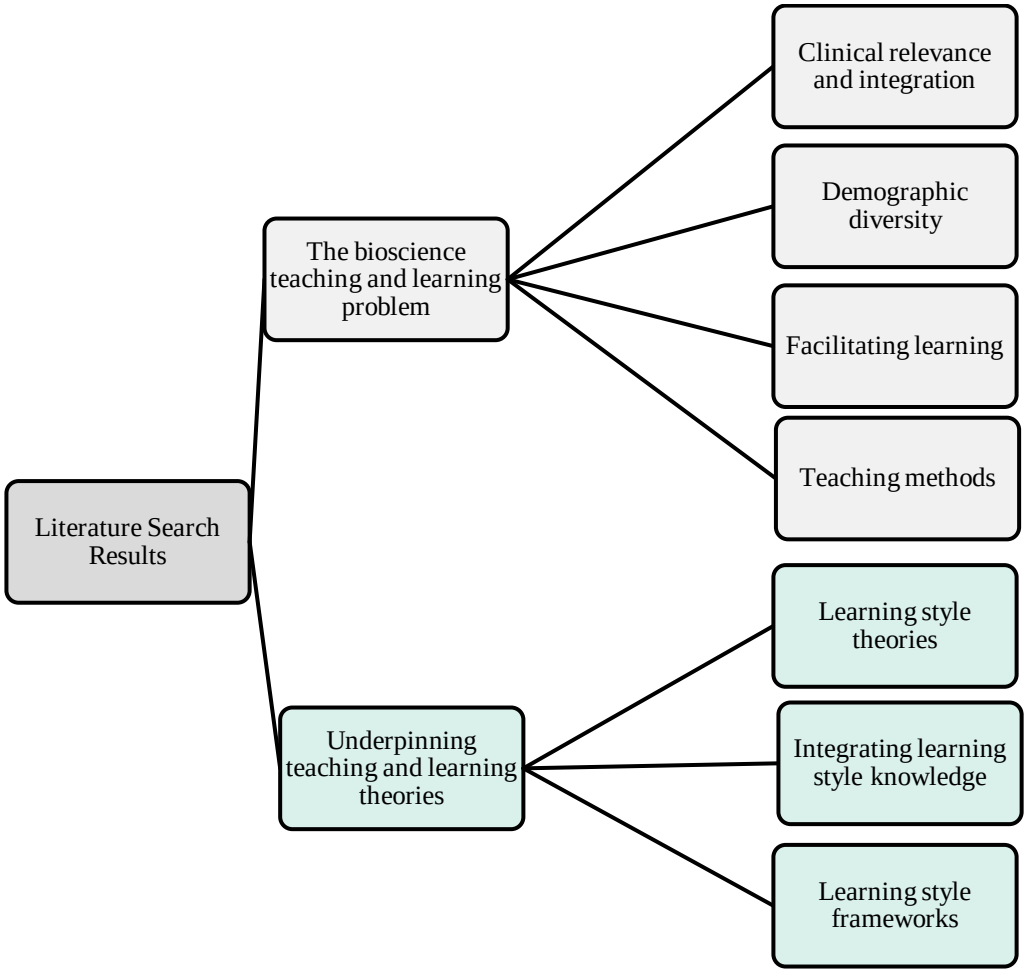


Figure 2.3 Summary of the themes evident in the literature

First, there appears to be numerous problems with the andragogic approach to bioscience concepts (Smales, 2010). Students are unable to understand the relevance and applicability of the concepts to clinical practice (Andrew et al., 2015). Nursing students have experienced several difficulties with learning bioscience concepts (Craft et al., 2013). They discussed feeling anxious, stressed and struggling with the terminology, which is compounded by the increased student diversity which has resulted from students with variable English language proficiency and limited academic capital enrolled in the program (Craft et al., 2013). Furthermore, students report being time-poor as they manage their competing interests including working, financial difficulties and their personal and social situations (Tabi et al., 2013).

These time constraint problems may then be exacerbated by an inadequate facilitation of education (Davis, 2010). The lack of an integrated and contextualised learning is a twofold concern; existing Registered Nurses and facilitators may not be confident in referring to bioscience in the clinical setting and the pathophysiological

links as a rationale for the provision of an appropriate nursing intervention. Furthermore, bioscience educators teach from a predominantly science background, and are commonly unable to provide relevant and appropriate contextualised examples of their content, as they lack clinical experience and/or exposure (Craft et al., 2013). Therefore, students experience significant learning difficulties and may be unable to understand the relevance of, or apply, integrate or translate bioscience theory to the clinical practice environment (Davis, 2010). The teaching methods currently used such as lectures are passive and students have reportedly experienced information overload with the content heavy information delivery (Efstathiou & Bailey, 2012).

Second, in reviewing the literature on learning styles theories, there appears to be ambiguity in the definition of learning styles, and therefore their applicability to nursing education (James et al., 2011; Romanelli et al., 2009). This has made the integration of this literature debatable (Cegielski et al., 2011). Despite the conjecture in various fields, learning styles have been accepted as an influencing factor on student learning and achievement (Kyprianidou et al., 2012; Threeton et al., 2013). Learning styles knowledge can be employed by educators to create an engaging and interactive learning environment (Hallin, 2014). Furthermore, students may be able to capitalise on this information and retain information more effectively if andragogical styles were more harmonious (Mayfield, 2012).

Lastly, various tools have been developed, based on differing frameworks, to assist with learning styles identification and in developing appropriate teaching models that cater to a diverse student cohort (McCrow et al., 2014). For example, Honey and Mumford's LSI was developed from an accepted learning cycle theory to assist students to understand their learning preferences, and recognise that while a student may have one dominant learning style, overall learning engages multiple cognitive aspects (Wilkinson et al., 2014).

2.6.1 Knowledge Gaps

Due to the difficulties that nursing students are experiencing in their learning of bioscience, further research into the learning approaches of nursing students is required. This research may highlight a teaching method to raise the confidence of nursing students in recognising pathophysiological concerns, drawing links,

assimilating this information, and reinforcing it to translate into effective and appropriate clinical practice.

Béres et al. (2012) suggest that even within academic fields, learning environments can vary considerably. As bioscience is an area in which student nurses experience significant concerns, more research into the learning styles of student nurses in this environment is warranted. Nursing educators may be aware of individual student differences, but how these personal characteristics manifest or influence learning styles, and consequently how learning styles influence student achievement, has not been correlated or adequately integrated into a teaching model in the bioscience units of the undergraduate nursing program.

An exploration of this gap in the literature may lead to an understanding of how nursing students learn and the methods they employ. Understanding how students learn is a valuable insight that can highlight whether the current teaching model is appropriate, or if educators need to address teaching and curricular development from a more holistic angle such as, through the consideration of multiple learning styles within their teaching approach.

These research gaps as detailed in Table 2.4 highlight the complexity of complying with NMBA National Registered Nurse Standards for Practice, and specifically ensuring safe, responsive nursing practice if complex biological concepts are not fully understood before a treatment is commenced. Thus, conducting studies into the learning styles and study strategies of nursing bioscience students utilising validated evaluative tools may make a significant contribution to the education, content, delivery mode choice and curriculum development for undergraduate nurses, and highlight the current trend in how learning strategy and styles influence academic achievement.

Table 2.4 *Summary of key issues from the literature*

What is already known about this topic	What is not known
• It is well documented in the literature that there are numerous problems with the teaching and learning of bioscience to nursing students. • Learning styles have been successfully used in other fields to assist students learning. • Learning styles reflect a student's study strategy and learning preferences.	• What are the learning styles preferences or study strategies used by nursing students in their learning of bioscience content? • Does a nursing students' learning styles influence their academic success?

2.7 DEVELOPING A CONCEPTUAL MODEL

Nursing students' lack of effective learning in bioscience which results in rote assimilation of content has potential implications for patient safety within the clinical environment (Smales, 2010). The application of bioscience and pathophysiology knowledge is vital to the detection of clinical deterioration, the provision of effective treatment interventions, and consequently the patients' health outcome. Moreover, nursing students have the professional responsibility to integrate these concepts with their practical skills to ensure their patients wellbeing (Davis 2010; Andrew et al., 2015). Indeed, patient safety, an accurate health assessment, and the implementation of evidenced based interventions that are clinically supported and appropriate, are a requirement of the National Registered Nurse Standards for Practice (NMBA, 2016). Therefore, to meet these requirements and ensure the health and wellbeing of vulnerable patient populations, this knowledge and integration deficit needs to be addressed. In consideration of this issue, a conceptual model was developed by the researcher to synthesise the literature surrounding the learning process and influences of achievement within the bioscience education of Registered Nursing students (Figure 2.4). The development of this model provides a visual representation of the multifactorial and indeed the overlapping multidimensional nature of nursing student learning in bioscience education.

The development of a conceptual model is useful when researchers need to understand the relationships between multiple complex factors that influence a central issue (Johnson & Henderson, 2011). In this study the central issue is nursing students learning in bioscience. Indeed, the development of a conceptual model is an initial step in the creation of a more detailed quantitative model (Johnson & Henderson, 2011). Conceptual models clarify what is already known about this topic and what is not known to explore the relationships and associations between the variables.

In developing the conceptual model, the key elements or descriptive themes identified in the literature review formed the initial basis as variables or elements requiring consideration within nursing student learning in bioscience. Indeed, the overlap of concepts and colour transitions indicate the interconnectedness of these elements. These elements include: 1) The student experience: including the demographic diversity, their negative perception of bioscience, their stress, anxiety, academic transition into university; 2) Student learning: including elements that may affect learning such as their prior learning experiences in bioscience or experience within the healthcare industry, learning styles theories, and the employed learning frameworks; and 3) The educational approach: including the methods through which learning is facilitated, the teaching methods employed and the need for clinical relevance and integration. The conceptual model developed shows the hypothesized relationships between the various elements and the central issue that is nursing student learning in bioscience.

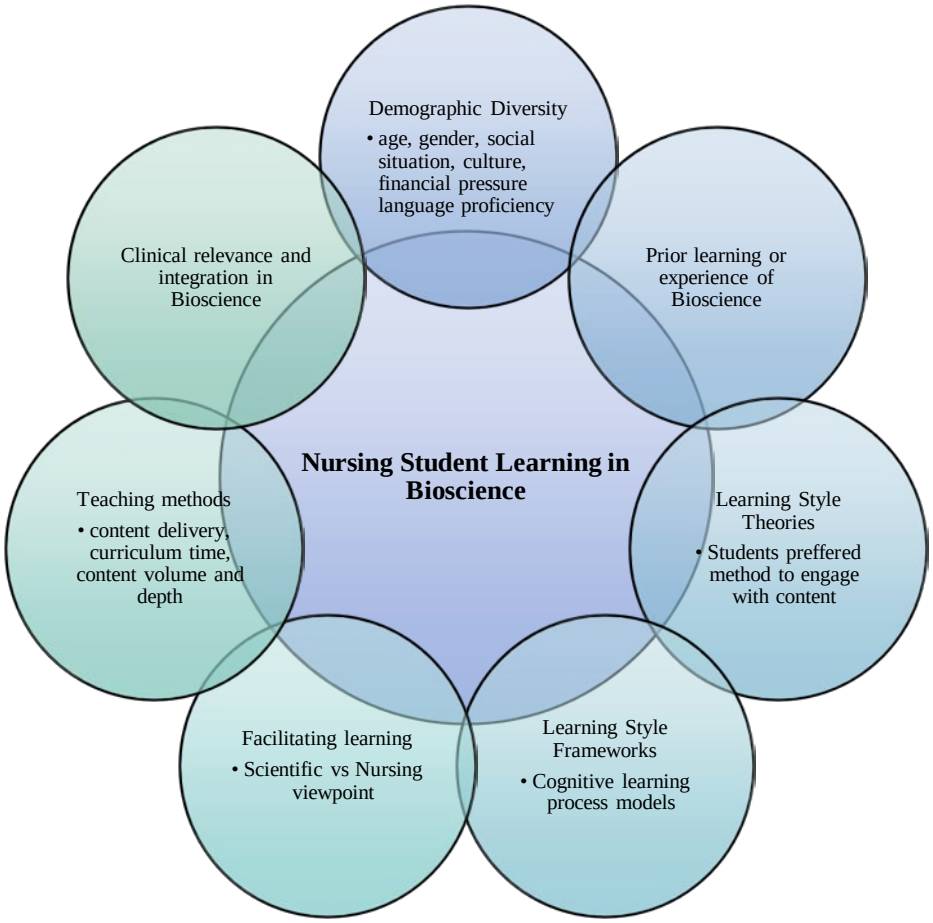


Figure 2.4 Conceptual model of key elements influencing nursing student achievement in bioscience education

2.8 CONCLUSIONS

There is an expectation that at the completion of their undergraduate program, nurses will be able to appropriately and adequately integrate their bioscience theoretical learning, and apply it to complex practical situations. Nursing students have reported consistent problems with this integration and experience anxiety, a lack of confidence, and difficulties with learning the required content. This may be due to individual characteristics, a lack of clinical relevance and integration of bioscience content, the teaching methods employed, and the methods through which learning is facilitated. Furthermore the student's prior learning or experience of bioscience in healthcare, their learning style and the learning style framework or process of learning may influence nursing student learning in bioscience.

Learning styles theories and their subsequent tools have been shown to assist the student to understand their learning style preferences, and therefore utilise learning strategies that will facilitate effective learning. Learning styles literature is well documented in other health care fields, where Kolb's Experimental Learning Cycle and the subsequent Honey and Mumford LSI have been employed. Despite this literature, learning styles theories have not yet been applied to the bioscience learning of nursing students where students continue to experience significant difficulties.

A literature search was conducted that explored the demographics that contributed to the teaching and learning problem in the bioscience units of the undergraduate nursing program, and a conceptual model was devised detailing the elements that influence nursing student education in bioscience. The diversity of this student cohort, the evidence and integration of learning styles literature in various fields, and the multitude of frameworks and tools available to determine individual learning styles was also explored. There is a paucity of evidence delineating the learning styles employed by this cohort of students, specifically within their bioscience learning where they experience considerable concerns. Therefore, this study was designed to determine the learning styles employed by nursing students within the bioscience units, and explore a possible relationship between individual student characteristics, learning styles, and student achievement.

The following chapter (Chapter 3) will discuss the methodology used for this research including the research design, sampling method, data collection and ethical considerations.

Chapter 3: Methodology

Chapter 3 describes the research design utilised in this study to achieve the aims and objectives stated. These include establishing the relationship between the learning styles employed by nursing students in their study of bioscience, and their academic achievement. Section 3.1 provides the aims and objectives that guided this research. Section 3.2 details the research strategy utilised in the study, and the six steps involved in survey research. Following discussion on the research strategy, the research design (section 3.3), and the participants approached for the study (section 3.4) will be outlined. Section 3.5 delineates the ethical considerations of the research details. The research instrument (section 3.6), methods employed in data collection (section 3.7), and data entry (section 3.8) are discussed. An overview of the statistical analysis procedures (section 3.9), and result interpretation (Section 3.10) follow. Section 3.11 provides a methodological summary to conclude the chapter.

3.1 RESEARCH AIM AND OBJECTIVES

This study aimed to identify what learning styles nursing students used in their learning of bioscience concepts, and to explore the relationship between the learning styles used and the students' resultant academic achievement. The study objectives were to address the following research statements:

1) to explore the different learning styles adopted by nursing students in their study of the bioscience subjects;
2) to identify whether student characteristics influence:
    a. the learning styles employed; or
    b. the achievement of nurses in bioscience education; and
3) to identify if particular learning styles correlate with higher academic achievement in bioscience compared to others.

3.2 RESEARCH STRATEGY

According to Christensen et al. (2014) there are six steps in survey research-

1. Plan and design the research study
2. Collect/refine the survey instrument
3. Collect the survey data
4. Enter and clean
5. Analyse the survey data
6. Interpret and report the results.

3.3 STEP 1: PLAN AND DESIGN THE RESEARCH STUDY

This research was a quantitative cross-sectional survey. Cross-sectional studies are observational research in which the researcher does not manipulate the participant's environment; they strictly record information about their participant population at a single point in time (Hall, 2008). The aim of this type of research is to evaluate if there is a correlational relationship between the aspects or variables they are studying (Hall, 2008). This design is useful in nursing research when the aim is to understand the relationship between sets of variables such as learning styles and academic achievement (Bowden, 2011). Cross-sectional studies can also be used to assess relationships without participant manipulation, where one set of data is used and multiple outcomes can be observed (Mann, 2003). This approach was the most appropriate design as the researcher is able to compare variables concurrently and is able to determine the prevalence of a variable in a given population (Mann, 2003). Furthermore, this methodology allows the researcher to examine the differences in the participants such as a non-English speaking background, previous knowledge of bioscience, university campus, gender, age, and healthcare experience, and explore how these differences may have influenced the relationship (Bowden, 2011).

3.3.1 Variables

There are numerous types of variables; this research has investigated the relationship between several independent and dependent variables that are ordinal, dichotomous and nominal in nature. Independent variables are those that influence or affect another variable which can be referred to as dependent variables (Independent

variables, 2004). The independent variables included in this study were the participant characteristics which included a non-English speaking background, previous knowledge of bioscience such as from secondary school, gender, age, cultural heritage, and healthcare industry experience. These independent variables are intrinsic participant factors that the literature identifies as key influences on the dependent variables (Craft et al., 2013; Tabi et al., 2013) and their rationale for data collection is detailed in Table 3.1.

Table 3.1 *Rationale for independent variable data collection*

Independent variables	**Rationale for data collection**
Age Gender Non-English speaking background Cultural heritage	There is an underrepresentation of minority groups in the nursing profession and in the Bachelor of Nursing programs including men, mature age, racial and ethnic minorities (Tabi et al., 2013). These students may experience feelings of loneliness, isolation and additional academic and financial pressures and as such they may perceive their educational experience differently (Tabi et al., 2013). There is a varying demographic and difference in study programs offered between the metropolitan and regional campuses, therefore resources and services available may differ.
Previous bioscience knowledge Prior industry experience	Craft et al. (2013) found that prior knowledge or exposure to bioscience concepts for example from secondary schooling, or experience, influenced students' perception of bioscience.

Dependent variables are those variables which are assumed to depend on or be influenced by the independent variable, which in the current study are the student characteristics (Dependent variables, 2004). There were two dependent variables: the student's learning style utilised in their study of bioscience content, and the student's academic achievement. The student's learning styles were identified through the use of Honey and Mumford's LSI 80-item version, which will be discussed in more detail in section 3.6.2. The student's academic achievement was determined by the grade point average (GPA) they achieved within their bioscience units, and was employed as an indicator of academic success. GPA is defined as the student's result for a specified unit of study and can be calculated utilising the following equation:

$$GPA = \frac{\Sigma \text{ (credit points of unit X numeric value of grade for that unit)}}{\Sigma \text{ credit points of unit}}$$

Therefore this project utilised a cross-sectional survey design, to determine the relationship between one variable (student learning styles) with another variable (GPA), with consideration given to the independent variables (student characteristics) associated with this specific student population (Connelly, 2014).

3.4 PARTICIPANTS

3.4.1 Participant recruitment

The participant sample was recruited through a recruitment email which contained a link to the online survey and was sent through the student email system (Appendix C). This email was sent to the prospective participants with the participant information sheet (Appendix D) attached to ensure open disclosure. The ethical approval number was included and a link to the online survey was provided. Follow up emails were also sent by the researcher after two weeks to encourage participation.

The survey asked the participants specific demographic questions which formed the independent variables, and included completion of the Honey and Mumford's LSI, to ascertain the participant's learning styles, which formed the first dependent variable. Furthermore, the survey requested access to the participants' GPA which formed the second dependent variable. Participants who had completed various bioscience units over the three year undergraduate program were sourced. This purposive sampling was designed to provide data on student success throughout the undergraduate Bachelor of Nursing program.

3.4.2 Eligibility Criteria

The participants included in this study incorporated first, second and third year nursing students who commenced a standard course enrolment in the course NS40: Bachelor of Nursing. This study included both a metropolitan and regional campus. These students needed to have successfully completed at least one unit of nursing bioscience education. These units included Bioscience 1 (LSB182: anatomy,

physiology and microbiology), Bioscience 2 (LSB282: pathophysiology and microbiology), Bioscience 3 (LSB382: pathophysiology and microbiology), and Understanding Disease Concepts (LSB111: anatomy, physiology and pathophysiology).

3.4.3 Participant Sample

The participants who completed the survey constituted a convenience sample. The sample was purposive in that a specific participant was sought through the use of an eligibility criterion (Creswell, 2009). A convenience sample is a non-probability sampling method, where the sample of participants is based on the convenience of the participant and their availability to complete the survey (Creswell, 2009). There were a total of 1,536 nursing students who met the eligibility criteria, and 70 opened the survey link for further information. This was a 4.55% response rate, indicating that this work may benefit from future larger scale studies. From the 70 participants that opened the link 31 did not consent to participate or respond to any survey items after they were provided with the participant information on the study. A total of N=39 students were included in the identification of learning styles, but seven participants did not consent for their grades to be correlated. Therefore two groups were formed within the data set-a group for the identification of nursing student learning styles consisting of N=39 participants, and a group utilised for the GPA correlation consisting of n=32 participants. The small sample size may affect the power of the study and the ability to detect differences between groups (Nayak, 2010). This in turn may lead to a failure to reject the null hypothesis when it is not true, otherwise known as a type two error (Nayak, 2010).

3.4.4 Study Setting

This study involved students enrolled at a university in South East Queensland. This university is one of Australia's leading universities with an estimated 45,000 students and approximately 2,409 of those students are currently enrolled in the Bachelor of Nursing program in 2016. This university has over 30 years of experience in nursing education.

3.5 ETHICS

Human Research Ethics Committee approval was obtained prior to commencement of data collection for this study (Appendix E). The ethical approval number was 1500000869.

3.5.1 Ethical Considerations

Researchers have an obligation to act and conduct their research in an ethical manner and in accordance with ethical guidelines to ensure the safety of their participants and the integrity of their research (Creswell, 2009). This research was deemed to be of negligible risk to its participants, as it only required the participants to complete an online survey which could be accessed at their own convenience. The questions asked were not of an evocative nature and should not have elicited any overwhelming emotional response. Nonetheless, details were provided to the participants to contact the researcher if they required further information on the study and for the Research Ethics unit. The Human Research Ethics Committee approved the procedures utilised in this study.

Throughout this study, the principles outlined in the National Statement on Ethical Conduct in Human Research and the principles described in the Code of Conduct for Research have been closely adhered to. Initially the Head of the School of Nursing was contacted for approval to approach the prospective participants.

3.5.2 Confidentiality, Anonymity and Consent

Confidentiality and anonymity are integral aspects of research ethics (Israel, 2015). Confidentiality may refer to the methods through which a researcher acquires data from research participants (Israel, 2015). These methods should ensure the participants' identities were not able to be identified by any other party (Israel, 2015). Anonymity considers the way in which the data is stored so that participants' identities are not re-identifiable (Israel, 2015).

Confidentiality was ensured as only the researcher had access to the data and the data they received was non-identifiable. An independent nursing administrative officer received the participant responses and matched these with the students GPA, then returned the data to the researcher without the student number ensuring participants remained anonymous. When a participant declined to participate in the survey, they were reassured in the participant information sheet that they could freely

choose not to respond as their decision to participate or not would not affect their relationship with their university.

Anonymity was ensured by storing the collected data in a de-identified format only on a password protected server. All information entered into data analysis software was non-identifiable and the data files remain on a secure server which requires access passwords. All data collected will be destroyed after seven years as per current data management protocols. The survey explicitly asked for consent and participants were informed that after submission of the survey it was not possible to withdraw. Hardicre (2014) suggest that a valid informed consent can only be obtained in research following comprehensive information about the risks, benefits and purpose of the research study. The participant information sheet provided details on the risks, benefits and direction of the study ensuring the participants informed consent was valid.

Students were reassured in the participant information sheet that the research team did not believe there were any risks beyond normal day-to-day living associated with their participation in this research. Students were provided contact details for the Research Ethics Unit and reassured that the Research Ethics Unit was not connected with the research project and could therefore facilitate a resolution to any concern that may have arose in an impartial manner. No concerns arose from the participants involved in this study.

3.6 STEP 2: COLLECT/REFINE THE SURVEY INSTRUMENT

The study employed email distribution (Appendix C) of a link to the survey which was comprised of demographic questions, the Honey and Mumford's LSI (Appendix F), an attached participant information sheet (Appendix D), and prize draw terms and conditions (Appendix G). Informed consent to access the participants' units' results for Bioscience 1 (LSB182), Bioscience 2 (LSB282), Bioscience 3 (LSB382), and Understanding Disease Concepts (LSB111) was explicitly requested and provided by those who completed the survey with the provision of the participant's student number for GPA correlation.

3.6.1 Demographic Questions

The demographic questions shaped Section A of the survey (Appendix F). Responses formed the independent variables which included participants identifying

non-English speaking background, gender, age, university campus, previous knowledge of bioscience from schooling and industry experience. Participants were then required to complete the Honey and Mumford's LSI 80-item version (Honey & Mumford, 1992).

3.6.2 Honey and Mumford's Learning Style Inventory

The Honey and Mumford's LSI formed Section B of the survey. This LSI was utilised to ascertain the learning styles employed by nursing students in their learning of bioscience (Appendix F). The inventory is an eighty item inventory, which through its psychometric properties, determines a person's preference for a particular learning style or styles. The individual items ask predominantly behavioural questions; for example, a preference for an action that someone may or may not undertake, rather than an actual manifested behaviour (Duff & Duffy, 2002). The inventory asks the participant for instance to agree or disagree with statements such as: "I have strong beliefs about right/wrong, good and bad" and "I tend to solve problems using a step by step approach."

Honey and Mumford's learning styles culminate in the participant indicating a preference which may be as a unimodal, bimodal, trimodal or quadmodal learner. There are four learning styles identified in Honey and Mumford's LSI that are influenced by Kolb's Experimental Learning Cycle. These learning styles include Activist based on Kolb's Concrete Experience, Reflector based on Reflective Observation, Theorist which aligns with Abstract Conceptualisation and Pragmatists which align with Active Experimentation.

The participants' preferences for various learning styles are identified based on a predetermined scoring card (Appendix H). For example, a participant that agrees with items 2, 4, 6, 10, 17, 23, 24, 32, 72, 74 and 79 would be identifying with items that indicate an Activist learning style. Other items on the inventory align with the Reflector, Theorist and Pragmatist learning styles. Honey and Mumfords scoring recognises the fluidity of learning styles and the diversity of learners by providing the percentage that each learner aligns with each of the differing learning styles (Fee, 2011). This scoring card consequently culminates in each participant indicating how strongly they align with each style and therefore a dominant style may become apparent.

3.6.3 Reliability and Validity of Honey and Mumford's Learning Style Inventory

A significant amount of research in the fields of business, higher education, health education, nursing and psychology justifies the use of this instrument including work by Swailes (1999), Duff and Duffy (2002), Rassool and Rawaf (2007), Kappe et al. (2009), and Wilkinson et al. (2014). Research by Kappe and colleagues (2009) in higher education suggest that the Honey and Mumford's LSI displays evidence of temporal stability, internal consistency and construct validity. According to Wilkinson et al. (2014) in their study on higher education psychology students the Honey and Mumford's LSI satisfies test-retest reliability and meets the minimum psychometric coefficients for internal consistency, construct validity and predictive validity, despite their study not testing or utilising the LSI for its psychometric properties.

Swailes (1999) details good test-re-test reliability using Honey and Mumford's LSI when employed within the business sector across a two week period; Spearman Rho Correlations from the initial test to the re-test were: Activist 0.70 (p=0.001); Reflector 0.64 (p=0.003); Theorist 0.90 (p=0.000) and Pragmatist 0.83 (p=0.000). Indeed, Kappe et al. (2009) found test-re-test reliability coefficients of Activists (r = 0.70), Reflectors (r = 0.63), Theorists (r = 0.50), and Pragmatists (r = 0.46) over a two year period. These coefficients demonstrate good stability.

Internal consistency is a measure of the reliability of an instrument (McCrae et al., 2011; Vaske, Beaman, & Sponarski, 2016). It can be described as how consistently an individual responds to several items on an instrument that are measuring the same construct (McCrae et al., 2011; Vaske et al., 2016). These coefficients are influenced by the length of the retest interval, which whilst the results are satisfactory, may explain the differing values noted between the following studies (McCrae et al., 2011; Vaske et al., 2016). Duff and Duffy (2002) in their study into higher education in business discussed modest findings of internal consistency for Honey and Mumford's learning styles using Cronbach's alphas: Activist, 0.68; Reflector, 0.73; Theorist, 0.57; and Pragmatist, 0.52 for the Honey and Mumford's learning styles. Cronbach's alphas measure the extent to which items on the instrument correlate with each other (Vaske et al., 2016). For example the extent to which two items on the Honey and Mumford's LSI correlate and therefore

measure the same construct or learning style. Rassool and Rawaf (2007) in their study into nursing education suggest that the LSI has demonstrated internal consistency coefficients of 0.89. Swailes (1999) found internal consistency values using Cronbach's alphas: Activist 0.72; Reflector 0.78; Theorist 0.67 and Pragmatist 0.61. Whilst these Cronbach's alphas may appear disappointing, it is inevitable that the alphas will be depressed as respondents are not expected to score all items within one construct, and therefore they are accepted as a satisfactory indication of the reliability of the tool to measure each construct (Swailes, 1999).

Discriminant validity is the measure that determines that items that should be unrelated within an instrument are indeed unrelated, and are therefore separate constructs (Sullivan, 2009). Discriminate validity was assessed by Swailes (1999) utilising rank order correlations. This analysis determined p values of 0.52 between Reflector and Theorist, -0.56 between Activist and Reflector, -0.39 between Activist and Theorist which indicates that the four learning styles are separate constructs on the Honey and Mumford LSI. Concurrent validity, or the ability of two test instruments to measure the same construct, is unable to be established or measured for the purposes of this study as no two learning style instruments measure learning styles in the same method. Furthermore, Honey and Mumford's LSI was not designed to be predictive. The use of the Honey and Mumford LSI within this study is retrospective in nature, in that this study is utilising the instrument to determine what learning style students used, post-completion of the unit of study. In this way, the current study is not predictive and therefore aligns with the accepted use of the instrument. Therefore, utilising this instrument the learning styles of participants were identified.

3.7 STEP 3: COLLECT THE SURVEY DATA

The survey link was generated by Key Survey software, which also collected and tabulated the responses indicated on the completed, submitted surveys. This link was distributed via the student email system, and the survey was available for a six week time period. Online research is an inexpensive method to reach large participant populations such as the nursing cohort as opposed to paper-based surveys (Bowden, 2011). The email distribution of an embedded hyperlink to access the survey permits the administration of more complex surveys (Administering instruments on the internet, 2004). Email is also a prudent method through which the

researcher can control the dissemination of their survey, and ensure it only reaches its intended target audience (Administering instruments on the internet, 2004).

3.8 STEP 4: ENTER AND CLEAN

At the completion of the specified data collection period, all data collected from the survey was entered into an Excel spreadsheet. Incomplete surveys were discarded. This process was repeated twice for verification of data entry. The spreadsheet was then provided to a third party administrative officer. This person randomly chose a participant from the pool provided to win the $200 gift card incentive. Arrangement for collection of the prize was organised as per the participant's convenience through this administrative officer. This person then inserted each participant's GPA result specifically in relation to their bioscience units into the data sheet, and removed the student number of the participant, thus rendering the data non-identifiable to the research candidate, and ensuring the participants anonymity and confidentiality. The de-identified data was then sent back to the researcher for analysis, where it was entered into Statistical Package for the Social Sciences (SPSS) version 22 to be used in the following analysis.

3.9 STEP 5: ANALYSE THE SURVEY DATA

The de-identified data collected was entered into IBM SPSS Statistics version 22. The SPSS data descriptors were modified to reflect the data collected to ensure the appropriate responses were entered. Analysis of the generated data included non-parametric methods as the data sets were unequal and the study was exploratory in nature. Therefore, Descriptive statistics, Krukall-Wallis H Test, Spearman's Correlation Coefficient and Fisher's Exact Test were employed to analyse the data. To gain an understanding of the participant demographics and to answer research objective one, to explore the different learning styles adopted by nursing students in their study of the bioscience subjects, descriptive statistics including frequencies and percentages were employed.

Descriptive statistics were used to present quantitative descriptions of the participant sample in a manageable arrangement which forms the basis of quantitative analysis. As such, descriptive statistics provided a frame of context surrounding the participant sample and the direction of the study (Brown, 2010). Specifically, the descriptive statistics available in this study permitted the researcher

to explore how individual student characteristics may have influenced their achievement, thus addressing the second research statement guiding this study: to identify whether student characteristics influence their learning styles or achievement. The descriptive statistics in this study included (where appropriate) the mean, median, range and standard deviations. Frequencies and percentages were also provided to understand the personal and functional characteristics of the sample.

Descriptive statistics, the Krukall-Wallis H Test, Spearman's Correlation Coefficient and Fisher's Exact Test were employed, These were utilised in order to answer research objective two: to identify whether student characteristics (a) influence the learning styles employed, or (b) the achievement of nurses in bioscience education, and also research objective three: to identify if particular learning styles correlate with higher academic achievement in bioscience compared to others.

The Krukall-Wallis H Test, also known as the Kruskal-Wallis One-Way Analysis of Variance on Ranks, is a non-parametric method for the comparison of two or more samples of equal or disparate sizes (Salkind, 2007). The Krukall-Wallis H Test has four assumptions that must be met for accurate data interpretation. Assumption one is that there is one dependent variable that is measured at either the continuous or ordinal level such as GPA (Laerd Statistics, 2015a). The second assumption is that there is one independent variable that consists of two or more categorical, independent groups, such as campus location (Laerd Statistics, 2015a). Assumption three includes independence of observation which means that there is no relationship between the observations in each group of the independent variable, which can also be determined by each participant being included in only one group, for example each participant must be assigned one age range (Laerd Statistics, 2015a). Additionally, assumption four includes the determination of distribution of scores for each group of the independent variable for accurate interpretation (Laerd Statistics, 2015a).

This distribution can be assessed by a visual inspection of generated boxplots. If the boxplots are similar then this confirms that the data meets all four assumptions for this statistical method. If the boxplots are dissimilar then the interpretation must be made through determination of mean ranks (Laerd Statistics, 2015a). This method of analysis is a technique through which comparisons can be made on the individual

variables that define the sample and allow the researcher to draw inferences on the factors that contribute to student achievement in the bioscience units.

The Spearman Rank-Order Correlation calculates a coefficient represented as r_s or p which is a measure of the strength and direction of the association between two continuous, two ordinal or one ordinal and one continuous variable such as learning styles and GPA (Laerd Statistics, 2015b). Spearman's correlation has three assumptions that must be met. The first is that the data contains two continuous or ordinal variables and secondly that these two variables represent paired observations (Laerd Statistics, 2015b). These two assumptions are met in the study design. Student characteristics, learning styles and GPA can be categorised as ordinal variables. The third assumption is the determination of a monotonic relationship between the two variables. A monotonic relationship is a relationship where the value of one variable increases as value of the other variable increases or decreases or changes as seen in Figure 3.1 (Laerd Statistics, 2015b). This relationship is apparent in the data.

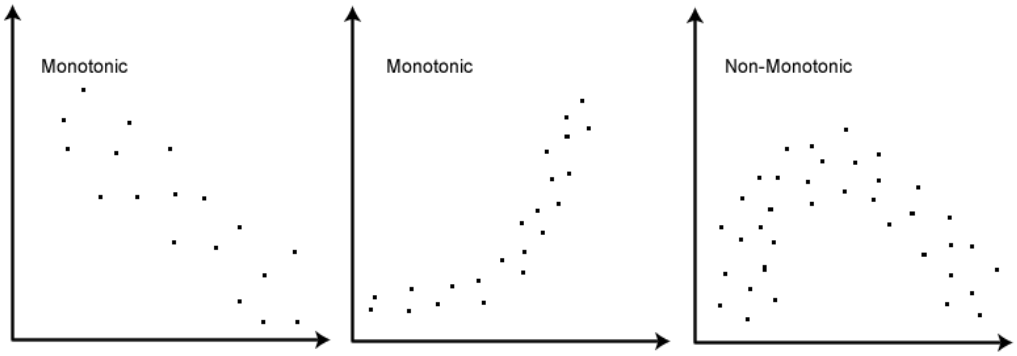


Figure 3.1 Monotonic and non-monotonic relationships on a scatterplot

Fisher's Exact Test is a statistical test used to determine the association or statistical significance between two dichotomous variables (Laerd Statistics, 2016c). This test was employed as it is primarily used when sample sizes are small, usually less than five per group, and therefore the data does not meet the assumptions for Pearson Chi-Square. This test was employed to determine the statistical significance between the independent and dependent variables. Fisher's Exact Test was used to provide the exact statistical significance or p-value, rather than an approximation that becomes exact as the sample size increases as in the Pearson Chi Square. In this way, it calculates the probability of the observed data with more extreme deviations under

the null hypothesis that all proportions are the same. It is used in conjunction with Phi φ tests that delineate the strength of these associations between variables (Laerd Statistics, 2016c).

3.10 STEP 6: INTERPRET AND REPORT THE RESULTS

The findings from this study have been documented in chapter 4 of this thesis. A summary of the research methodology utilised in this study is detailed below in Figure 3.2

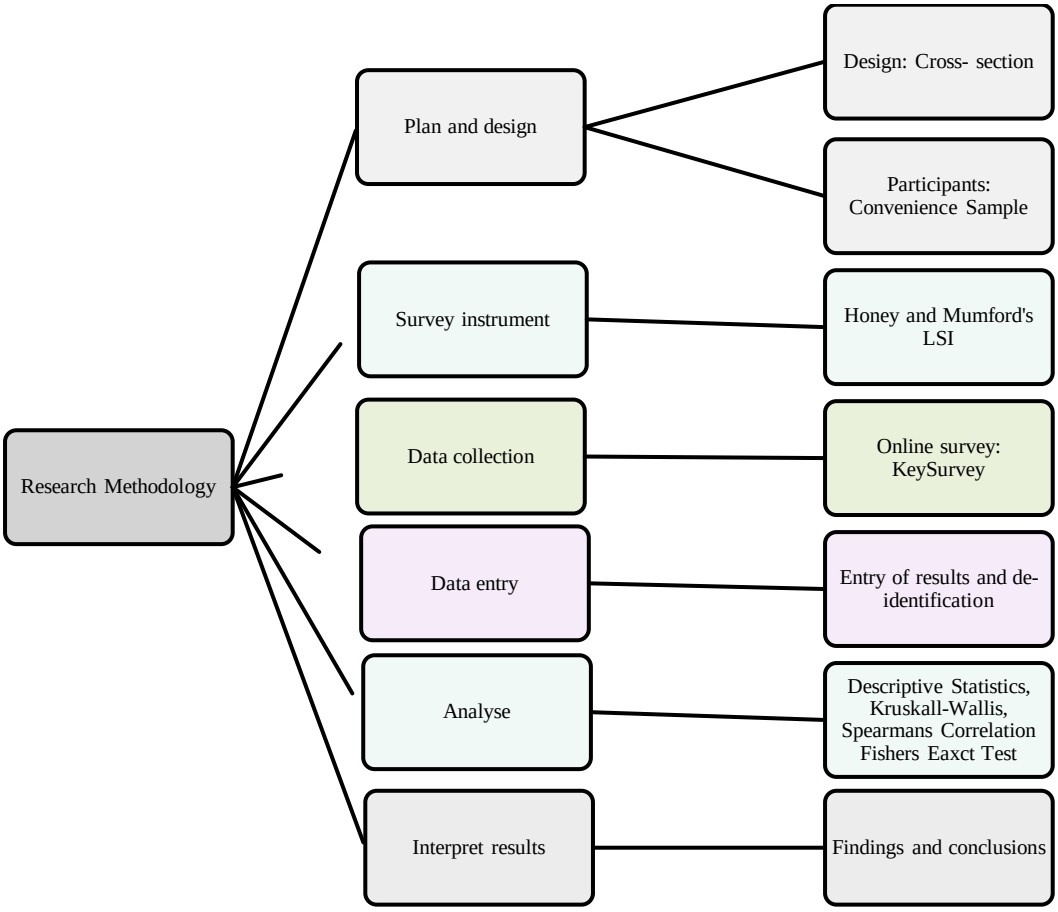


Figure 3.2 Survey research process

3.11 SUMMARY

This chapter reported the methodology underpinning the research design that was chosen to address the research aims and objectives posed in this study. The research design was appropriate for the research objectives. The independent and dependent variables were defined, including the participant inclusion criteria and convenience sampling method. The chapter then detailed the instrument employed for data collection and ethical considerations. The data analysis procedures applied

were appropriate to formulate conclusions to the research objectives which are discussed in the following chapters.

Chapter 4: Results

Chapter 4 details the research findings in relation to the objectives posed in this study. Section 4.1 provides an overview of the participant demographics; these are presented as frequencies and percentages of the total included participant sample. Means, medians, range and standard deviations are also provided (where appropriate) as is the non-parametric Kruskal-Wallis H Test which determines the difference between two or more groups and Fisher's Exact Test for associations. Section 4.2 details the results in relation to research objective one: to explore the different learning styles adopted by nursing students in their study of the bioscience subjects.

Section 4.3 provides the results to research objective two: to identify whether student characteristics influence the learning styles employed in the bioscience education of nurses or their achievement. Section 4.4 answers research objective three: to identify if particular learning styles correlate with higher academic achievement in bioscience compared to others. Section 4.5 concludes the chapter by providing a summary of the results for this study.

4.1 PARTICIPANT DEMOGRAPHICS

A convenience sample of 39 undergraduate nursing students participated overall in the study providing their student characteristics and learning styles, but only 32 consented for their GPA to be correlated with their survey results. Therefore two groups within the data set were employed. The first group (Students N=39) provided the distribution of student demographics presented in Tables 4.1 to 4.7 whilst, the second (n=32) was employed for analyses relating the students GPA. Most of these students (90%; n=35) identified as female and 10 % (n=4) identified as male. The highest percentage of students (44%; n=17) identified as being in the 17-20 years age bracket. Notably, the median age of participants was the 21-25 (SD 1.99) year old age range at 23% (n=9) and 10% (n=4) identified as 26-30 years. Furthermore, 18% (n=7) of students identified as from a non-English speaking background with students identifying their cultural heritage as Asian, Chinese, Indian, and Singhalese. The participants were spread between the metropolitan and regional campuses with 69% (n=27) of responding students from the metropolitan

campus and 31% (n=12) of students based at the regional campus. This distribution of students is not surprising due to the considerable difference in campus size and student intake numbers.

Table 4.1 *Nursing student demographics (N=39)*

Gender distribution N=39		
	Frequency	Percent %
Female	**35**	**89.7**
Male	4	10.3
Campus		
	Frequency	Percent %
Metropolitan	**27**	**69.2**
Regional	12	30.8
Detailed age ranges of included participants		
	Frequency	Percent %
17-20	**17**	**43.6**
21-25	9	23.1
26-30	4	10.3
31-35	2	5.1
36-40	2	5.1
41-45	1	2.6
45+	4	10.3
Age range descriptive statistics		
N	Range	Median	Std. Deviation
39	17-45+	21-25	1.99
Non-English speaking background		
	Frequency	Percent %
English as first language	**32**	**82.1**
Non-English Speaking Background	7	17.9

Many, students (69% n=27) had previous learning in bioscience despite there being no prerequisite for admission into the Bachelor of Nursing program. When asked if students had prior employment in the healthcare industry 28% (n=11) identified that they had experience in the healthcare industry in other capacities (Table 4.2; N=39).

Table 4.2 *Frequency of prior knowledge and experience (N=39)*

Prior knowledge of bioscience N=39		
	Frequency	Percent
No Knowledge	12	30.8
Knowledge	**27**	**69.2**
Prior experience in the health care industry		
	Frequency	Percent
No Experience	**28**	**71.8**
Experience	11	28.2

4.2 RESEARCH OBJECTIVE 1

What learning styles were adopted by nursing students in their study of bioscience subjects?

According to Honey and Mumford (1992) each learner and therefore each participant has a dominant or preferred method of learning but will also show some degree of preference for multiple other learning styles (Appendix I). According to the Honey and Mumford's scoring card a twenty-five percent or twenty items are employed to gauge a students' preference for each style. Indeed, a student may indicate some preference for multiple styles of learning. This occurs as learners adapt their learning styles to the content and learning environment. Yet, even though there was some preference for each style indicated, the Reflector learning style was the style predominantly employed (Table 4.3; N=39).

Table 4.3 *Participant percentage preference for each learning style (N=39)*

Activist %	**Reflector %**	**Theorist %**	**Pragmatist %**	**Dominant Style**
10.5% (25%)	**19% (25%)**	16.55 (25%)	14% (25%)	Reflector

Each student has some affinity for each learning style yet, by adding the eighty items from the inventory as indicated by the scoring card detailed in Appendix H, the

students' dominant learning style becomes apparent. The dominant style frequencies are reported in Table 4.4 (N=39).

Table 4.4 *Frequency of dominant learning styles (N=39)*

Dominant Learning Styles N=39		
	Frequency	Percent
Activist	0	0.0
Reflector	**23**	**60.0**
Theorist	6	15.4
Pragmatist	4	10.3
Multimodal	6	15.4
Reflector/Theorist	3	16.6
Theorist/Pragmatist	1	50.0
Pragmatist/Activist	1	16.6
Reflector/Pragmatist	1	16.6

Reflector was shown to be the dominant learning style employed with the highest frequency by 60% (n=23) of nursing students in this study. This was followed by Theorist learners 15% (n=6) and multimodal learners 15% (n=6). The multimodal combinations (15%) included Reflector/Pragmatist (n=1), Pragmatist/Activist (n=1), Reflector/Theorist (n=3), Theorist/Pragmatist (n=1). Pragmatist learners contributed only 10% (n=4) and no student was identified with a dominant Activist learning style.

4.3 RESEARCH OBJECTIVE 2

Do student characteristics influence:

a) the learning styles employed; or

b) the achievement of nurses in bioscience education.

Reflector was the dominant learning style expressed (60%; n=23) with the highest frequency by the nursing students involved in the study (Table 4.4). Within this study Reflector students tended to be female (n=21), in the 17-20 age range (n=9), from the metropolitan campus (n=15). Of these students n=5 identified a non-English speaking background, n=14 had prior knowledge of bioscience but only n=10 had prior healthcare experience.

In comparison, Theorist students, which comprised only 15% (n=6) of the sample, all Theorists identified as female, predominantly in the 17-20 age range (n=4), from the metropolitan campus (n=4). Theorist (n=4) students identified an English speaking background, n=5 had prior knowledge of bioscience whereas no Theorists had any background healthcare experience.

Pragmatist learners comprised 10% (n=4) of the sample and tended to be female (n=3) in the 17-20 age range (n=3) from the metropolitan campus (n=4) with only n=4 identifying a non-English speaking background. Pragmatist students (n=3) had prior knowledge in bioscience but no Pragmatists had prior healthcare experience.

Multimodal learners constituted 15% (n=6) and primarily identified as female (n=5), in the 21-25 age range (n=3), and were based at the metropolitan campus (n=4) with only n=6 identifying a non-English speaking background. Most multimodal learners possessed prior knowledge in bioscience (n=5) yet most did not have any background experience (n=5) as indicated in Table 4.5 (N=39).

Across the sample the participants were predominantly English speaking (82%), female nursing students (90%), from the metropolitan (69%) campus, with prior knowledge in bioscience education (60%), yet no prior experience within the healthcare industry (72%). Therefore it can be reasonably inferred that the nursing program primarily attracts Reflector women with ready access to education and a burgeoning interest in healthcare.

Table 4.5 *Nursing student demographic distribution as frequency of learning styles (N=39)*

Frequency N=39		**Reflector**	**Theorist**	**Pragmatist**	**Multimodal**	**Totals %**
Gender	Female	**21**	**6**	**3**	**5**	**90%**
	Male	2	0	1	1	10%
Age	17-20	**9**	**4**	**3**	1	**44%**
	21-25	5	0	1	**3**	23%
	26-30	4	0	0	0	10%
	31-35	1	0	0	1	5%
	36-40	1	0	0	1	5%
	41-45	0	1	0	0	3%
	45+	3	1	0	0	10%
Campus	Metropolitan	**15**	**4**	**4**	**4**	**69%**
	Regional	8	2	0	2	31%
Background	NESB	5	2	0	0	18%
	No NESB	**18**	**4**	**4**	**6**	**82%**
Knowledge	Prior Knowledge	**14**	**5**	**3**	**5**	**69%**
	No prior knowledge	9	1	1	1	31%
Experience	Prior Experience	10	0	0	1	28%
	No experience	**13**	**6**	**4**	**5**	**72%**
Totals %		**60%**	15%	10%	15%	

Note: NESB indicates a Non-English speaking background

A Pearson Chi-square test for association was conducted between student demographics and learning styles. The data set failed to meet the assumption that all cell frequencies were greater than five. Therefore, Fisher's Exact Test was deemed more appropriate to determine the association between the variables. There was not a statistically significant association between student learning styles preference, and

their gender p=0.427. The strength of this association as measured using Phi φ was non-significant p=0.631. This relationship was also consistently demonstrated between learning styles and other student demographic variables (Table 4.6; N=39). For example, a non-statistically significant association and a non-significant strength of association was observed between the variables of learning styles and age range (p=0.394), learning styles and campus (p=0.599), learning styles and identifying a non-English speaking background (p=0.399), learning styles and prior bioscience knowledge (p=0.689), and learning styles and prior healthcare experience (p =0.088). These results likely arose from the small sample size and therefore the difference and association between these variables is not statistically conclusive as they may be type two errors.

Table 4.6 *The association and strength of association between learning styles and demographic variables (N=39)*

Learning Styles and Gender	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.437	
Symmetric Measures -Phi		0.631
Learning Styles and Age Range	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.394	
Symmetric Measures -Phi		0.352
Learning Styles and Campus	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.599	
Symmetric Measures -Phi		0.599
Learning Styles and NESB	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.399	
Symmetric Measures -Phi		0.348
Learning Styles and Prior Bioscience Knowledge	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.689	
Symmetric Measures -Phi		0.629
Learning Styles and Prior Experience	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.088	
Symmetric Measures -Phi		0.071

In relation to nursing student academic achievement the highest percentage of students (26%; n=10) received a grade of 5.0-5.49 on a seven point grading scale where 4.00 indicates a pass, 5.00 credit, 6.00 distinction and 7.00 high distinction. (Table 4.7; N=39). This was followed by students who received a seven or high distinction at 23% (n=9) which culminated in a mean overall bioscience GPA of 5.59 (SD 1.04) across the sample (Table 4.8; N=39). Almost half of the students (48.7%) participating in this study received only a pass or credit grade. When viewed in conjunction with the low mean GPA this suggests that students continue to experience difficulties in achieving success in their bioscience units.

Table 4.7 *Summary of grades achieved by nursing students in bioscience (N=39)*

Student grades identified N=39		
	Frequency	Percent
4.00-4.49	3	7.7
4.50-4.99	4	10.3
5.00-5.49	**10**	**25.6**
5.50-5.99	2	5.1
6.00-6.49	4	10.3
6.5-7.00	9	23.1
Total	32	82.1
Missing	7	17.9
Total	39	100.0

Table 4.8 *Summary of descriptive statistics for nursing student bioscience grades (n=32)*

Number	**n=32**	**Range**	**Mean**	**Median**	**Std. Deviation**
Total	32	3.00	5.59	5.33	1.04

Correspondingly, a Pearson Chi-square test for association was conducted between student demographics and GPA. The data set failed to meet the assumption that all cell frequencies were greater than five. Therefore, Fisher's Exact Test was deemed more appropriate to determine the association between the variables. There was not a statistically significant association between student GPA, and student gender p=0.918, and the strength of this association was not significant p=1.000. This relationship was also consistently demonstrated between GPA and other student demographic variables (Table 4.9; n=32). For example, a non-statistically significant association and a non-significant strength of association was observed between the variables of GPA and age range (p=0.325), GPA and campus (p=0.258), GPA and identifying a non-English speaking background (p=0.223), GPA and prior bioscience knowledge (p=0.516), and GPA and prior healthcare experience (p =0.467).

Table 4.9 *The association and strength of association between GPA and demographic variables (n=32)*

GPA and Gender	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.918	
Symmetric Measures -Phi		1.000
GPA and Age Range	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.325	
Symmetric Measures -Phi		0.358
GPA and Campus	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.258	
Symmetric Measures -Phi		0.361
GPA and NESB	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.223	
Symmetric Measures -Phi		0.273
GPA and Prior Bioscience Knowledge	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.516	
Symmetric Measures -Phi		0.452
GPA and Prior Experience	**Exact Sig (2-sided)**	**Exact Significance**
Fisher's Exact Test	0.467	
Symmetric Measures -Phi		0.408

The Kruskal-Wallis H Test was run to see if there were differences in the GPA between the age ranges of nursing students. The distribution was dissimilar, as assessed by visual inspection of a box plot (Figure 4.1). The differences in GPA distribution across the age ranges were not statistically significant $X^2(31) = 11.110$, $p=0.085$ (Table 4.10; n=32). Therefore, the mean ranks were compared.

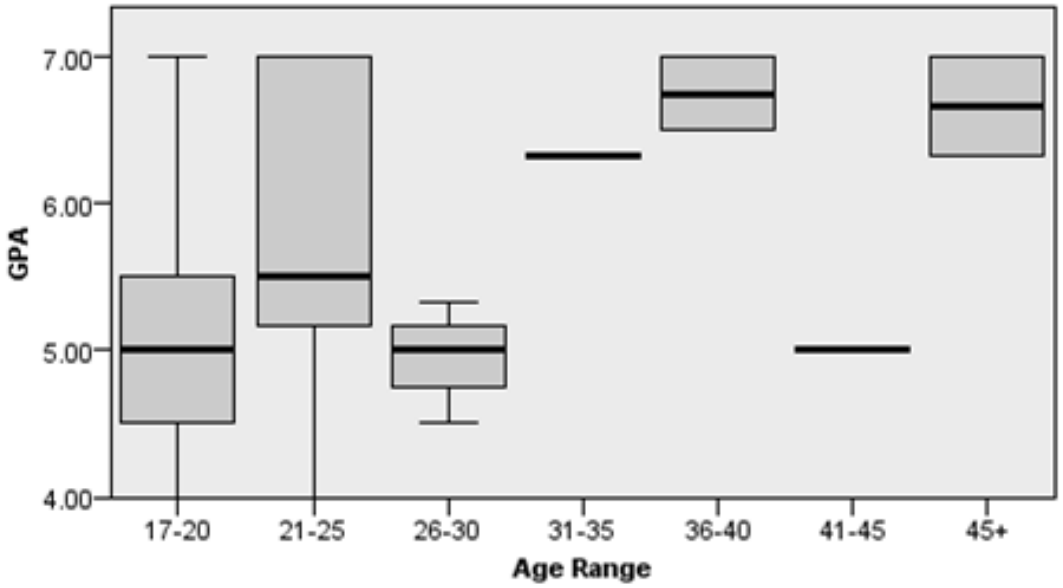


Figure 4.1 Dissimilar GPA distributions across age range (n=32)

Table 4.10 *Kruskal-Wallis H Test summary of GPA distribution across age range (n=32)*

Total N	32
Test Statistic	11.110
Degrees of freedom	6
Asymptomatic Sig. (2-sided test)	0.085

∗Asymptomatic indicates that the *p*-value approaches the real *p*-value as size increases therefore the *p*-value reported is only an approximation that will improve with increased sample numbers. Confidence interval 95% Significance 0.05

The mean GPA varied in age range groups: for example, the 17-20 age range had a mean GPA of 5.15, 21-25 age range had a mean GPA of 5.83, 26-30 age range had the lowest mean GPA of 4.95, 31-35 age range had a mean GPA of 6.33, the 36-40 age range had the highest mean GPA of 6.75, 41-45 age range had a mean GPA of 5.00, and the 45+ age range had a mean GPA of 6.65 (Table 4.11; n=32).

Table 4.11 *Kruskal-Wallis H Test mean rank differences in GPA between age ranges (n=32)*

	Age Range	N	Mean	Std. Deviation
GPA	17-20	13	5.15	0.97
	21-25	7	5.83	1.19
	26-30	4	4.95	0.34
	31-35	1	6.33	.
	36-40	2	6.75	0.35
	41-45	1	5.00	.
	45+	4	6.65	0.39
	Total	32	5.59	1.04

The mean GPA result was not statistically different between age ranges $X^2(6)=11.1110$, $p=0.085$. Students in the 17-20, 21-25, 36-40 and 45+ age ranges were all able to obtain the highest grade result of 7.00 or a high distinction (Figure 4.2). These results demonstrate that attaining academic success in the bioscience study of student nurses appears to be irrespective of age. Indeed, the standard deviation demonstrates a high level of variance within the results for each age range. Whilst these results were statistically insignificant approximately half of the students (n=20) participating were under the age of 25 and received a mean GPA in the range of a credit grade (5.00-6.00). Whilst students over 31 years old (n=8) achieved higher mean GPA results. This discrete pattern may indicate inconsistency within the data set and a need for further definitive research on the influence of age on academic achievement in bioscience.

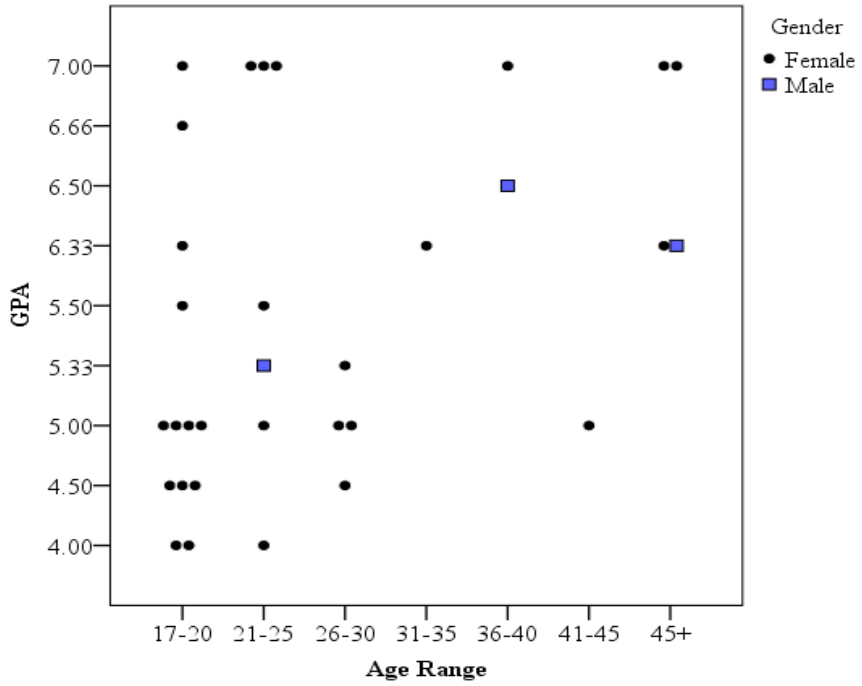


Figure 4.2 Scatterplot distribution of students' age range and gender against GPA (n=32)

Students with prior knowledge of bioscience had a mean GPA of 5.70 (SD 1.04) whereas, students without any prior bioscience learning had a mean GPA of 5.31 (SD 1.03). When considering the interplay of prior knowledge and prior experience; experience did not appear to be a significant influence on GPA (Figure 4.3). Students with no experience (n=23) yet had prior knowledge of bioscience had a mean GPA of 5.68 (SD 1.02). Students with experience in healthcare yet had no prior knowledge in bioscience had a mean GPA of 4.77 (SD 0.69). This indicates that prior knowledge of bioscience has a more significant influence on GPA than experience in the healthcare industry in relation to bioscience achievement.

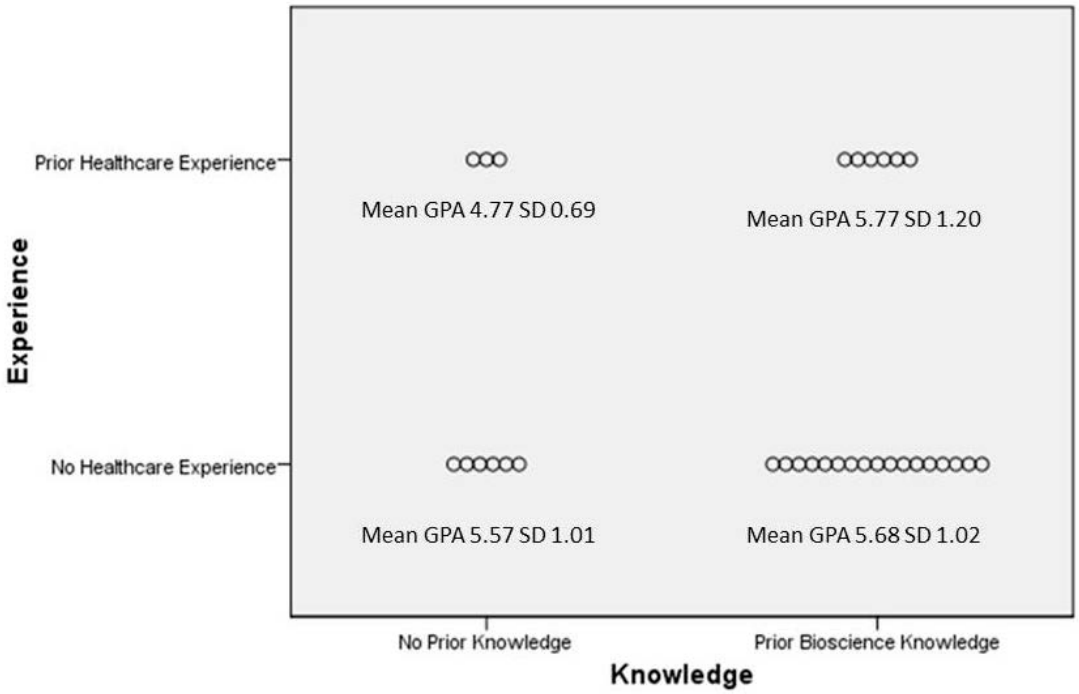


Figure 4.3 Summary of mean GPA of nursing students with and without healthcare experience and/or prior knowledge (n=32)

4.4 RESEARCH OBJECTIVE 3

Does one learning style correlate with higher academic achievement in bioscience compared to others?

The Kruskal-Wallis H Test was employed to determine if there was a statistically significant difference across the groups of learning styles in regards to their GPA result from their bioscience units. This test determined that there was not a similar distribution between the learning styles (Figure 4.4) as assessed by visual boxplot inspection. Therefore, the distribution of GPA was not statistically different between learning styles, $X^2(6) = 3.950$, $p=0.683$ (Table 4.12; n=32).

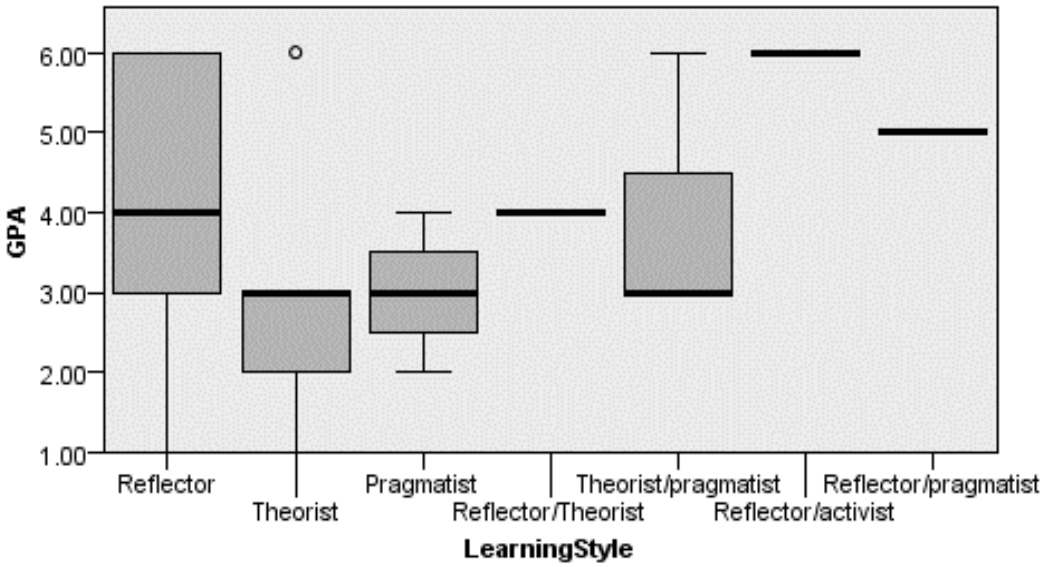


Figure 4.4 Dissimilar GPA distributions across learning styles (n=32)

Table 4.12 *Kruskal-Wallis H Test summary of GPA distribution across learning styles (n=32)*

Total N	32
Test Statistic	3.950
Degrees of freedom	6
Asymptomatic Sig. (2-sided test)	.683

∗Asymptomatic indicates that the *p*-value approaches the real *p*-value as size increases therefore the *p*-value reported is only an approximation that will improve with increased sample numbers. Confidence interval 95% Significance 0.05

Due to the dissimilar boxplots the mean ranks were required to be compared. The mean GPA for all learning styles expressed, ranged from 5.00 to 7.00 (Table 4.13; n=32) with the dominant learning style with the highest frequency; Reflector (n=18) demonstrating a mean GPA of 5.69 (SD=1.09).

Table 4.13 *Range of mean GPA for identified learning styles (n=32)*

Learning Styles	Mean	N	Std. Deviation
Reflector	**5.69**	**18**	**1.09**
Theorist	5.10	5	1.14
Pragmatist	5.00	3	0.50
Reflector/Theorist	5.50	1	.
Theorist/Pragmatist	5.77	3	1.07
Pragmatist/Activist	7.00	1	.
Reflector/Pragmatist	6.33	1	.
Total	5.59	32	1.04

Whilst the multimodal learning styles such as Reflector/Activist and Reflector/Pragmatist have a higher mean GPA of 7.00 and 6.33 respectively, they are not statistically significantly due to the small sample size. The dominant learning style with the highest frwquency: Reflector, whilst having a mean GPA of 5.69 (SD 1.09) is individually quite distributed and not indicative of success on a 7.00 grade scale (Figure 4.5). This distribution demonstrates that the dominant learning style of student nurses is not necessarily indicative of academic success.

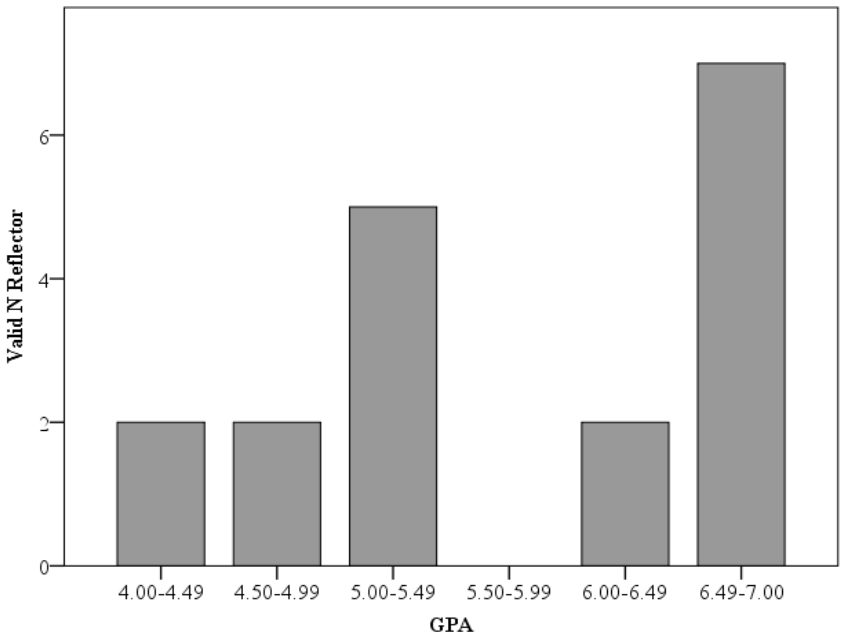


Figure 4.5 The GPA distribution of the dominant Reflector learning style (n=18)

As no specific learning styles were able to be correlated with student success a Spearman's rank-order correlation was undertaken to assess the relationship between nursing students' learning styles and academic success. Preliminary analysis showed the relationship to be monotonic, as assessed by visual inspection of a scatterplot (Figure 4.6) and therefore the data met the assumptions for the test.

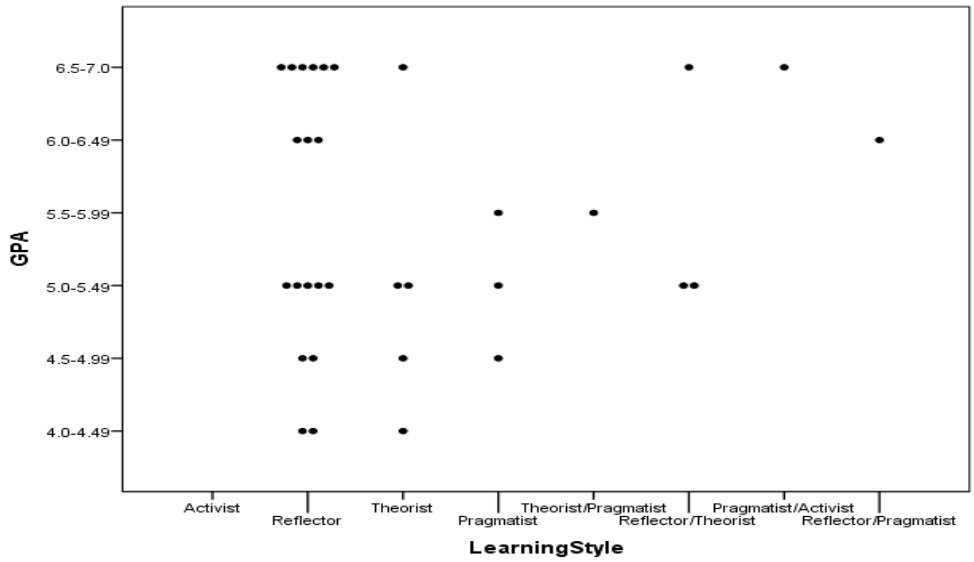


Figure 4.6 Monotonic relationship on scatterplot between learning styles and GPA (n=32)

According to Dancey and Reidy (2014), correlations between zero and ± 0.1 indicate that there is no correlation between the variables. Employing this definition on the strength of positive and negative correlation coefficients, the Spearman's Rank-Order Correlation employed in this study indicated that there was no correlation between the learning styles employed in bioscience and the nursing students academic achievement ($r_s(30)=0.033$ $p=0.856$; Table 4.14; n=32).

Table 4.14 *The Spearman's Correlation Coefficient and significance between the relationship between students learning styles and GPA (n=32)*

		n=32	**Learning Style**	**GPA**
Spearman's rho	Learning Style	Correlation Coefficient	1.000	0.033
		Sig. (2-tailed)	.	0.856
	GPA	Correlation Coefficient	0.033	1.000
		Sig. (2-tailed)	0.856	.

4.5 SUMMARY

The results of this study indicate that whilst learning styles vary between individual nursing student demographics, their influence on students learning styles cannot be definitively concluded. The learning styles used by nursing students included Reflectors (60%, n=23) Theorists (15%, n=6), Pragmatist (10%, n=4) and multimodal 15% (n=6). The multimodal combinations (15%) included Reflector/Pragmatist (n=1), Pragmatist/Activist (n=1), Reflector/Theorist (n=3), Theorist/Pragmatist (n=1). The dominant learning style with the highest frequency was apparent as the Reflector learning style yet this style did not produce the highest mean GPA (5.69, SD 1.09). While Pragmatist/Activist and Reflector/Pragmatist have a higher mean GPA of 7.00 and 6.33 respectively the sample size was too small to be considered significant.

The results demonstrated no correlation between the identified learning styles used in bioscience and academic achievement, due to the small sample size ($r_s(30) = 0.033$ p=0.856). The following chapter, Chapter 5 will discuss the results in relation to the current literature.

Chapter 5: Discussion

Chapter four presented the results from this study. These results pose several implications for student learning, and how this may relate to both student achievement of learning outcomes and a fulfilling student experience (Owens & Moroney, 2015). Therefore, Chapter five will discuss the findings of this study in consideration of the literature surrounding these results. This discussion will initially consider the extant literature related to the study (section 5.1). The first research objective: to explore the different learning styles adopted by nursing students in their study of the bioscience subjects will be discussed in section 5.2. Subsequent sections will discuss research objectives two; whether student characteristics influence the learning styles employed in the bioscience education of nurses and their achievement (Section 5.3) and research objective three which explores whether one particular learning style correlated with higher bioscience grade outcomes (Section 5.4). Section 5.5 will discuss the limitations of this study and section 5.6 will conclude by summarising the main discussion points.

5.1 LITERATURE REVISION

The literature was revised after the results of this study were determined to locate extant literature published after the initial literature review. The search process included the databases employed in the initial literature search namely; CINAHL, ERIC, Science Direct, Web of science and ProQuest. The search terms used included: (1) biological science, (2) bioscience, (3) education, (4) learning styles, and (5) nursing. The search terms corresponded with those employed in the initial literature search and were integrated with the Boolean operators “and” and “or” to create appropriate search phrases. The MeSH heading employed included: nursing [MH] and education [MH].

Inclusion criteria were applied to refine the search results. Therefore, literature was sourced from peer-reviewed journals with abstracts, full text and references available. Papers that were included were those that were published between 31/12/2015-01/03/2017. Papers published in a language other than English were excluded to prevent translational and cultural misinterpretations. There was no

restriction on the study design. Duplicates were removed then the papers were critically appraised utilising the CASP (2013) Critical Appraisal Checklist (Appendix J). This search process, outlined in a PRISMA flowchart (Figure 5.1), resulted in the inclusion of a further ten papers.

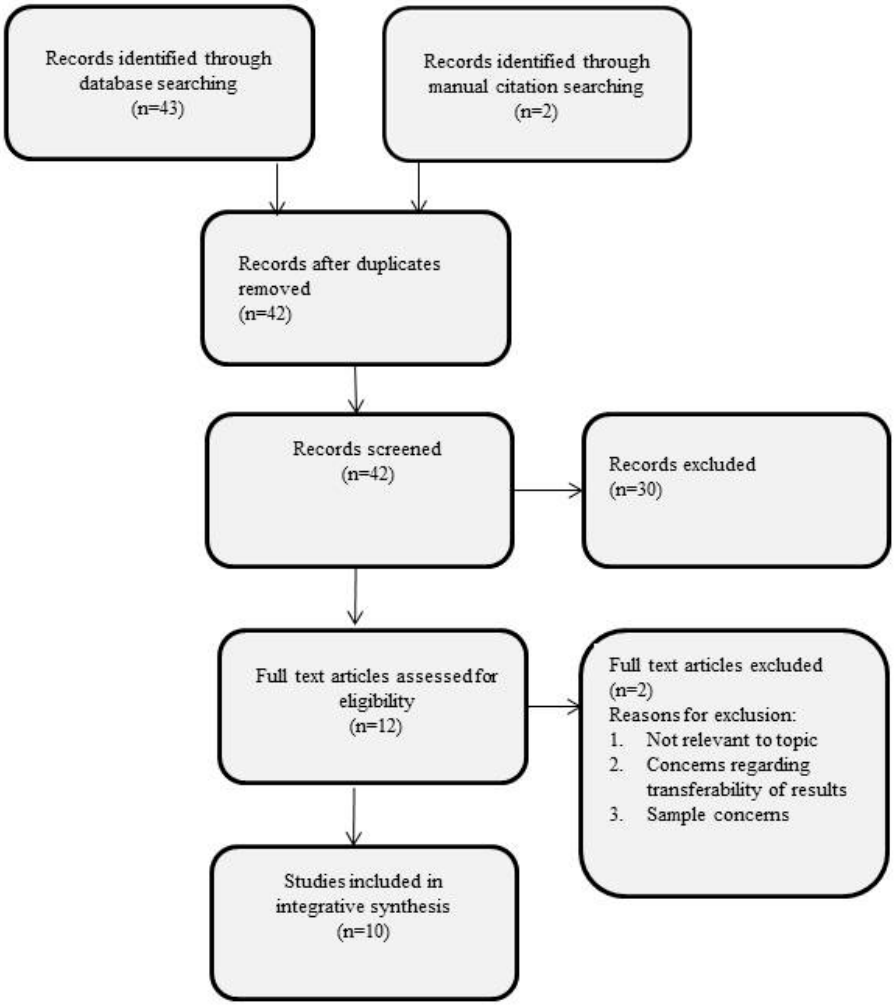


Figure 5.1 Extant literature search results

The results from this literature search are discussed in relation to the results and the research objectives in the following sections.

5.2 RESEARCH OBJECTIVE 1

What learning styles were adopted by nursing students in their study of bioscience subjects?

The results suggest that nursing students employ a range of learning styles including Reflector, Theorist, Pragmatist, Activist, and Multimodal strategies in their

learning of bioscience concepts. This poses numerous considerations for the for the nursing academic and bioscience educator in terms of providing an effective learning experience. Therefore an in-depth discussion on the types of learning activities that may promote effective learning in each style-Reflector, Theorist, Pragmatist, Activist and Multimodal follows.

5.2.1 Reflector

The Reflector learning style was shown to be the dominant learning style (60%; n=23) with the highest frequency. This learning style has been described as involving learning where the student reflects on and analyses their experiences to reach conclusions (Fee, 2011; Honey & Mumford, 1992). Honey and Mumford (1992) originally described the Reflector as a learner who observed multiple perspectives, considered all available data before making decisions, are thoughtful, adopt a low profile, and act as part of a bigger picture. These personality descriptors align with role of the nurse. For example, The Registered Nurse Standards for Practice (2016) state that a RN respects all cultures and experiences (NS 1.3), accesses and analyses evidence (NS 1.1), develops practice through reflection on experiences (NS1.2), and collaboratively constructs nursing practice (NS 5.2). Therefore alignment between the contemporary role of the nurse in the healthcare environment and the personal attributes of student nurses from this study may provide insight as to why nurses generally tend to be reflectors.

Reflective learning is encouraged in the National Registered Nurse Standards for Practice in NS 4.1 the Registered Nurse "*…considers feedback from colleagues about and critically reflects on, own nursing practice…to identify professional development needs* (NMBA, 2016, p.5)." Fleming et al. (2011) and Honey and Mumford (1992) suggest that students employing the Reflector learning style may predominantly learn more effectively through observation and critical thinking. Indeed, Oh, Gagné and Kang (2013) suggest that discussion, feedback, problem-based learning activities and the presentation of material from multiple perspectives may result in an enhanced learning experience for Reflector learners. For example, discussion may be facilitated through small group debates, seminars and film analysis, feedback may be encouraged in presentations and open questions that encourage comprehension, and writing reflective essays may foster critical thinking (Oh et al., 2013; Tsingos Bosnic-Anticvich & Smith., 2015).

Reflections from clinical placements may be used by students to identify areas of weakness in their bioscience knowledge (Gordon & Hughes, 2013). Brett-Maclean, Cave, Yiu, Kelner and Ross (2010) suggest that reflection is a valued and highly encouraged learning strategy within healthcare. This contrasts with the favoured content delivery modalities employed in the bioscience education of nurses from this study. The content heavy lectures and science based tutorials currently employed in bioscience units may not promote effective learning for the nursing student with a dominant Reflector learning style (Efstathiou & Bailey, 2012; Meehan-Andrews, 2009; Sinclair & Ferguson, 2009). This may be due to the lack of experiential learning within bioscience units. Students with a dominant Reflector learning style need to reflect on concrete experiences, such as observable disease processes experienced in clinical placements Therefore, the students from this study who predominantly employed the Reflector learning style may have difficulties assimilating bioscience content that is not placed within a nursing context. The provision of an appropriate clinical context appears to be integral to the learning of nursing students in bioscience (Clifton & McKillup, 2016; Smales, 2010). Gordon and Hughes (2013) suggest integrating bioscience with clear clinical examples and contextualised assessments may allow nursing students to comprehend the relevance of bioscience and make connections between knowledge and application. Yet, Craft et al. (2013) suggested that bioscience educators may not be able to provide examples of bioscience content within a nursing context and that this remains a barrier to the effective facilitation of bioscience education.

5.2.2 Theorist

Theorist learning was the dominant learning style for 15% (n=6) of the students that participated in the study. Theorist learning has been suggested as learning that requires logically sound theories, frameworks or models to assimilate analyse and synthesise information (Honey & Mumford, 1992). It has been suggested that students with a dominant Theorist learning style may benefit from learning that includes applying theories and statistics (Honey & Mumford, 1992). DiBartolo, Salimian, Kotteman and DiBartolo (2012) suggest that the inclusion of statistics as a teaching approach in undergraduate nursing may be instrumental in providing an understanding of the importance of evidenced-based practice within nursing and consequently, the key role of research within clinical practice.

Statistics can be easily integrated into bioscience teaching to provide context for Theorist learners as they are a method in which students can identify the significance, prevalence of and mortality associated with disease processes (DiBartolo et al., 2012). For example around 1.7 million Australians have been diagnosed with Diabetes Mellitus (Diabetes Australia, 2015). This statistic provides a scope of the healthcare problem and indicates the prevalence in which the student may encounter the disease in their nursing care. Incorporating statistics may assist nursing students in understanding where bioscience concepts are relevant to their clinical practice and how bioscience may guide the care they provide (Andrew et al., 2015).

Additionally, McCrae (2012) suggests that theoretical frameworks in nursing combine the remarkable diversity of theoretical, objective and subjective knowledge that guides nursing care and professional practice. Therefore, bioscience educators should facilitate the integration of theoretical frameworks within the employed nursing model of care to provide guidance and structure for the dominant Theorist learner. To provide an example, the PQRST (P=P wave, QRS=QRS complex, T=T wave) discussed when learning cardiac electrical conduction and evident on diagnostic assessments such as an Electrocardiogram (ECG) is also a mnemonic used in nursing chest pain assessment. The PQRST discusses provocation (P), quality (Q), radiation (R), severity (S) and timing (T) of the chest pain as detailed in figure 5.1.

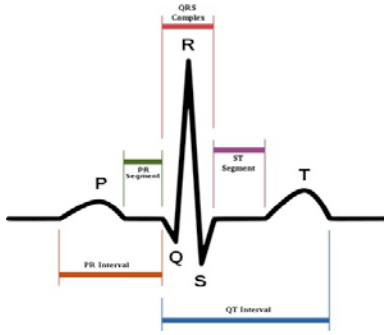
Does the ECG have all elements?	PQRST	Questions
	P- Provocation	What provokes the pain?
	Q- Quality	Can you describe the pain?
	R-Radiation	Does the pain radiate anywhere?
	S-Severity	Out of ten how bad is your pain?
	T- Timing	When did the pain start and what were you doing at the time?

Figure 5.2 Integration of bioscience content and nursing chest pain assessment mnemonic.

5.2.3 Pragmatist

Pragmatist learning was the dominant mode for only 10% (n=4) of the student sample. Dominant Pragmatists learners have been described as proactive learners who learn through the practical application of content including theories and techniques into real world situations (Honey & Mumford, 1992). Honey and Mumford (1992) suggest that individuals dominant in the Pragmatist learning style learn effectively through case studies, problem solving, problem-based and interactive learning opportunities. Problem-based learning is highly structured and includes multiple aspects including the utilisation of real problems encountered as the starting stimulus for learning. Problem-based learning encourages thinking in terms of problems to be addressed within context rather than learning individual concepts, that learning is student initiated and that learning should be fostered within groups (Lin, Lu, Chung & Yang, 2010). A lack of knowledge integration is notably a concern within the bioscience education of nurses', therefore utilising this method, bioscience educators may be able to engage nursing students, provide clinical examples to demonstrate relevance and foster the integration of bioscience knowledge to clinical practice (Davis, 2010). High fidelity simulation may be another avenue to provide real world context and assist student link to theory to practice. Hallin (2015) suggested that high fidelity simulation was not only positively perceived but was an effective method to bridge the theory practice gap within nursing.

5.2.4 Activist

The Activist learning style describes learners as those that learn through trial and error or practical kinaesthetic activities: they often employ brainstorming to form solutions (Honey & Mumford, 1992). Learners employing the Activist learning style may benefit from group discussions, problem solving, and interactive practical and simulated role-play learning opportunities (Honey & Mumford, 1992; Wagner, 2014). Johnston et al. (2015) also suggests that hands-on or kinaesthetic activities such as dissection, experimentation or laboratory work may provide an effective learning opportunity for these students. Indeed, Salvage-Jones et al. (2016) found hands on learning activities enhanced student learning and the students perception of their learning. Whilst no student in this study identified predominantly as an Activist learner it was prudent to include discussion on Activist learning as not all participants that met the inclusion criteria participated and aspects of Activist learning may be relevant to the multimodal learner.

5.2.5 Multimodal

Multimodal learners comprised 15% (n=6) of the sample and included students with equally dominant learning styles including Reflector/Pragmatist (n=1), Pragmatist/Activist (n=1), Reflector/Theorist (n=3), and Theorist/Pragmatist (n=1) combinations. These learners employ a range of different learning strategies to amalgamate information and learn effectively (Honey & Mumford, 1992). Teaching strategies or learning activities that incorporate aspects of multiple learning styles may enhance the educational experience of multimodal learners (Honey & Mumford, 1992). Bloomfield, Cornish, Parry, Pegram and Moore (2013) suggest that teaching using a multimodal approach maximises learning opportunities. This approach may incorporate a variety of teaching and assessment strategies including self-directed e-learning, clinical skill workshops, group discussions, seminars, formative and summative assessments (Bloomfield et al., 2013; Wagner, 2014). Owens and Moroney (2015) contribute to this discussion suggesting that in teaching bioscience, educators need to include various teaching and learning strategies to accommodate the diversity of the current nursing cohort.

Hallin (2015) has suggested that nursing students feel motivation, satisfaction and engagement when andragogy is congruent with learning styles; therefore as multiple styles were present any approach developed or implemented may need to be

multidimensional. Honey and Mumford (1992) and Lum, Bradley and Rasheed (2011) suggest that no student learns exclusively in one style and that learning styles are not absolute; they appear to be a preference for a particular approach which the student finds more effective. Additionally, Pashler et al. (2008) also suggests that students will change their learning style based on the content or material. They continue this discussion suggesting that identifying optimal instructional approaches for different disciplines rather than students may be a method to optimise curriculum learning (Pashler et al., 2008). For example, geographical studies require the use of maps and charts, and therefore visual spatial material may be more appropriate, whereas a journalism program of study will no doubt place an emphasis on writing skills.

Blended teaching approaches that incorporate the teaching and learning strategies preferred by each learning style preference namely: Reflector, Pragmatist, Theorist and Activist, may then offer bioscience educators a method through which they can optimise the learning of nursing students. Blended learning is an approach that combines multiple methods of learning (DeLozier, 2016). A summary of the different teaching and learning activities preferred by each learning style is depicted below (Table 5.1). Redmond et al. (2016) suggests that a blended approach provides students with both the theoretical knowledge and practical skills required within nursing. Indeed, this approach may also prove to be cost effective as Pashler et al. (2008) suggest that the expense of assessing individual student preferences for learning styles, then grouping students based on these preferences, followed by customised educational instruction may be an expensive endeavour in consideration of the large student cohorts within nursing programs.

Table 5.1 *Summary of the learning activities preferred by each learning style, Adapted from Fee, (2012).*

Learning Activity	Activist	Reflector	Theorist	Pragmatist
E-learning	✓	✓	✓	
Resource Learning		✓	✓	
Action Learning	✓			✓
Practical Instruction	✓	✓		✓
Work-based Learning	✓	✓	✓	✓
Didactic Coursework		✓	✓	✓
Participative Coursework	✓	✓	✓	✓
Performance review		✓	✓	✓
Assessment		✓		✓

5.3 RESEARCH OBJECTIVE 2

Do student characteristics influence:

a) the learning styles employed; or

b) the achievement of nurses in bioscience education.

Historically, individual student demographics have been researched as predictors of academic achievement and performance, yet learning styles theories lead to the conclusion that the relationship between individual student differences and achievement is moderated by both teaching and learning styles (Furnham, 1992). Lum et al. (2011) suggests that the characteristics of the learner including their learning styles may need to be taken into consideration in the development and facilitation of learning experiences that meet student needs and encourage a deep understanding of course content. Despite this premise, this study determined that whilst the dominant learning style employed was the Reflector learning style, the relationship between student characteristics and subsequent learning styles was not significant. These characteristics which included gender, age range, campus, a non-English speaking background, prior bioscience knowledge and prior healthcare

industry experience were not significantly associated with the students dominant learning style or their academic achievement in bioscience. Therefore, identifying cohort demographics and determining learning styles may be only an initial step in understanding the complexities of the learning process and may have more significant implications for student support programs (Cegielski et al., 2011).

Whyte et al. (2011) found that nursing students were predominantly female and that a significant portion of the students were mature aged. They suggested that the demographic profile of nursing students requires consideration as many student factors may influence student performance and the learning experience (Whyte et al., 2011). Furthermore, Whyte et al. (2011) observed that mature entry, previous tertiary learning and prior knowledge of bioscience had a positive relationship with student performance. Indeed, Newton, Smith, Moore and Magnan (2007) and Whyte et al. (2011) suggested that prior learning in bioscience and mature aged students generally tended to perform well academically. Whilst this trend was observed, the results of this study contrasted with these findings due to the small sample size and the inability to conclude statistical significance. The results of this study align with research by Ali and Naylor (2010) who also found that non-academic factors such as age, gender, location and entry pathway and prior learning were not necessarily associated with improved academic performance.

Johnston et al. (2015) and Whyte et al. (2011) suggest that other factors rather than inherent student characteristics were the key determinants of student success in bioscience units. For example, Salamonson et al. (2016) suggested that low socioeconomic standing may affect student achievement. Yet, this contrasts with research by Amankwaa, Agyemang-Dankwah and Boateng (2015) who found that inherent student factors including their sociodemographic characteristics were not predictors of either success or learning. Johnston et al. (2015) suggested and indeed this study supports the notion that academic aptitude may be more generally related to achievement in bioscience and that by increasing the amount of time that a student effectively engages with content material-the time on task-may therefore support active learning and influence academic outcome and student satisfaction.

In addition, Newton et al. (2007) suggest behavioural and environmental variables may influence achievement. This may include the ability to access information and the time to devote to learning (Newton et al., 2007). Therefore, the

achievement of nursing students in bioscience education cannot be ascribed individually to student cohort demographics. Koch et al. (2014) surmises that nursing academics may need to re-evaluate how these student characteristics and cohort demographics can impact the students learning styles and academic success in bioscience.

5.3.1 Capitalising on Student Demographics

Whyte et al. (2011) suggest that cohort demographics could instead be used for the early identification and support of students that may require added learning assistance, such as those without prior bioscience study or current computer literacy. These inherent student characteristics such as lower socio-economic backgrounds, identifying as the first in their family to attend university, English as a second language, part-time employment or alternative pathway entry may have limited academic capital (Johnston et al., 2015; Salamonson et al., 2011). These student characteristics were not surveyed within the course of this study yet Craft (2013) found in her study on commencing student perceptions of bioscience in nursing that over 30% of the cohort were mature aged students. Additionally Gordon et al. (2016) in their study on nursing student's experiences with bioscience found 70% had no prior post-secondary education. Therefore, large percentages of nursing cohorts may have limited academic capital and may require additional learning support.

The multiculturalism and diversity apparent in nursing may pose additional challenges for nursing academics and bioscience educators who may struggle to adapt their teaching methods to meet the needs of the diverse nursing student cohort (Lum et al., 2011). While this study did not demonstrate any link between the students' language background and success other studies have suggested that academic performance may be related to language acculturation (Salvage-Jones et al., 2016).

Learning support professionals and tutors who have individualised contact with students may have the ability to maximise learning by capitalising on knowledge of individual student characteristics and learning styles (Mayfield, 2012). This information may be valuable in the choice of subsequent methods used to present information and address learning objectives (Mayfield, 2012). Indeed, students need to address the required learning outcomes that will allow them to meet professional expectations (Lum et al., 2011). For example, providing a flowchart of a disease

process with the use of key words as a stimulus may be a more effective teaching strategy for a pragmatic learner with English as a second language as they may have difficulty understanding terms if this was explained verbally (Mayfield, 2012).

Disappointingly the student experience may not have been always taken into consideration in course or program design, often as a result of a strong focus on cost-effectiveness, and accountability, and less on the individual undergraduate learner (Lum et al., 2011). Consideration of the factors that influence the student learning experience may assist in providing appropriate support and improving the educational experience of the student (Fiedler, Giddens & North, 2014; May, Wedgeworth & Bigham, 2013). Moreover, the learning experience of nursing students in bioscience is of particular relevance, considering the perceived anxieties academic disadvantage and content related difficulties that students report in their learning of this subject (Craft et al., 2013).

Indeed, Kelly, Lyng, McGrath and Cannon (2009) recommend that the development of learning support resources, strategies and approaches may require bioscience educators and indeed, nursing academics to consider these student presumptions, expectations, and prior study skills. Nursing academics play an important role in the construction of a learning environment that is conducive to the needs of students in respect to their learning styles and individual characteristics in both the clinical and academic environments (DelPrato, 2013). Therefore, nursing academics may need to consider teaching strategies that will improve the student learning experience and consequently their achievement, as this increase in achievement may then translate into safe, competent, nursing care (Bhatti & Bart, 2013).

Ensuring consistent student performance, standardisation, and accommodating educational diversity may prove conceptually problematic within bioscience education and therefore requires consideration (Lum et al., 2011). These programs may need to be flexible in their design yet still meet the requirements for accreditation and subsequent professional registration (Lum et al., 2011). It may be advantageous for universities to explore adjusting or expanding their learning support mechanisms, to assist these diverse nursing students to improve their academic achievement and enhance the student learning experience (Holtbrugge & Mohr, 2010; Salamonson et al., 2011).

5.4 RESEARCH OBJECTIVE 3

Does one learning style correlate with higher bioscience grade outcomes compared to others?

Avillion (2009) has suggested that for nursing academics to formulate teaching plans that positively influence student performance; they need to understand their students' learning styles. This study identified that nursing students, in their learning of bioscience concepts, employ a range of learning styles, furthermore, there was a no correlation between the students learning styles and their academic achievement. For example, the multimodal learning styles including Pragmatist/Activist and Reflector/Pragmatist demonstrated a higher mean GPA of 7.00 and 6.33 respectively, yet these results were not statistically significantly due to the small sample size identified as this type of learner. Nonetheless, whilst it may be functionally difficult for a nursing academic or bioscience educator to possess prior knowledge of students' learning styles preferences before commencement of pre-arranged teaching plans, nurse academics and bioscience educators can maximise their student's potential by being aware of learning styles theory and delivering content through multiple methods thus catering to the diversity of the learning styles present (Avillion, 2009; Cegielski et al., 2011; Fleming et al., 2011).

Current literature by Andreou et al. (2014) and Blevins (2014) support the view that the learning process and student achievement is greatly improved through the early involvement of learning styles recognition. Therefore, bioscience educators may need to embrace and actively develop teaching strategies that are innovative in nature to facilitate the learning and achievement of this specific and diverse cohort of nursing students (Fiedler et al., 2014). Indeed, Pashler et al. (2008) concludes that it is integral to explore all avenues and methods to improve students' capacity to learn.

Traditional teaching methods including lectures appear to not meet the learning needs of students or adequately prepare these students with the knowledge required for practice within the nursing profession (Fiedler et al., 2014). The use of lectures has been associated with rote learning rather than fostering of critical thinking and reasoning skills due to its passive delivery style and the large volume of content (Al-Modhefer & Roe, 2010; Biggs, 2012). This learning mode has long been criticized as outdated and ineffective (Meehan-Andrews, 2009; Smales, 2010). Andreou et al. (2014) suggest that through the integration of learning style theories effective critical

thinking may be fostered. Critical thinking is a vital process within the nursing profession, as this will allow the nurses to ensure positive patient outcomes (Levett-Jones et al., 2010). As such, employing learning style theory into nursing education programs may enhance the students' ability to integrate crucial knowledge and effectively contribute to their profession. Integrating learning style theory may include altering current teaching strategies to improve teaching practices, and assisting bioscience educators to critically evaluate their role as a service provider (Li, Chen & Tsai, 2008). This may include altering curriculum time, and providing content delivery in workshops with smaller student clusters (Taylor et al., 2015).

5.4.1 The Blended Teaching Approach

Various teaching approaches including the efficacy of different modes of content delivery have been researched to assist the learning, facilitation and translation of bioscience education for nursing students, but the research is less than conclusive. As multiple learning styles were identified in this study, the use of a multimodal or blended teaching and learning approach would appear to be the most appropriate framework to employ. Indeed, within this study Reflector, Activist, Pragmatist, Theorist and multimodal learning styles were evident. The greatest support indeed, appears to be for blended models of teaching that aim to facilitate learning by the provision of education through multiple learning styles.

Alkhasawneh et al. (2008) suggests that most students are able to learn effectively if the academic provides learning activities in various styles utilising active learning techniques such as problem-based learning, demonstrations, discussions and answering questions. These blended learning approaches are flexible and do not discount diverse learning modalities (Johnston et al., 2015). Specifically, blended learning approaches include multiple strategies that align with students various learning styles such as Activist, Pragmatist, Reflector and Theorist to teach students key concepts.

For example, Gordon and Hughes (2013) employed online clinical case studies and assessments where students must explain the pathophysiology behind clinical presentations. This method provided relevance and context which are then discussed in tutorials to optimise comprehension and identify knowledge deficits (Gordon & Hughes, 2013). Whereas, Swift, Efstathiou and Lameu (2016) employed online software in their bioscience unit that provided students with a patient focussed

problem as a form of PBL through which they had to apply their learning in small groups. This program challenged surface learning of bioscience material by challenging students to apply it within a nursing scenario therefore engaging the student in deeper learning (Swift et al., 2016). The nursing students in this study found it was easy to relate the material to practice through this e-learning platform and the group collaborations fostered the increased engagement and discussion required for effective learning (Swift et al., 2016).

In addition to tutorials and online forums, blended learning may also include team-based teaching and laboratory work. Team-based teaching employs the use of both a bioscience educator and a nursing academic to teach the bioscience concepts. A study by Christensen et al. (2015) found that students felt that the increased depth of pathophysiology knowledge gained from a bioscience educator was valuable, and a nurse teaching alongside the bioscientist was an effective teaching approach to assist in integrating and translating the relevance of pathophysiology concepts to their clinical practice. Clifton and McKillup (2016) suggest bioscience educators need a solid content knowledge and the ability to place bioscience theory within a nursing context. Furthermore, Johnston et al. (2015) in their study on teaching methods for nursing students found that 86.6% of students found laboratory activities helpful. Laboratory activities such as dissection could be employed to provide kinaesthetic learning opportunities (Johnson et al., 2015). These active learning activities aim to increase the amount of time a student is engaged with the content (Johnson et al., 2015).

Likewise, active learning activities may be integrated into tutorials and use a variety of (1) auditory elements such as hearing and speaking elements, and (2) visual and hands-on learning and teaching components (Johnson et al., 2015). For example, in considering bioscience theory surrounding cardiac conduction, the bioscience educator could engage students by designing a multifaceted activity. This activity may include the students performing an ECG tracing and then matching the phases of electrical conduction-the PQRST, to the consequent mechanical action and identifying where abnormalities will be evident in a patient in a suffering a myocardial infarction. They can then link this knowledge to the nursing chest pain assessment mnemonic to identify their nursing assessment and management responsibilities. This activity caters to all four learning styles as the activist can be

actively involved in performing an ECG, the Theorist can employ frameworks to assimilate the knowledge, the Pragmatist is provided a real world scenario and the Reflector can reflect on this activity to apply it within the nursing clinical environment.

Johnson et al. (2015) suggest that tutorial activities can foster engagement with academics and peers. Furthermore, designing teaching approaches with student involvement allows the students to identify the value of their learning, and provides the academic the opportunity to understand the student's perspectives and meet their expectations. Therefore, integrating learning activities favoured by the four learning styles suggested by Honey and Mumford (1992) with blended learning theories may deliver an optimal learning environment for the bioscience education of nursing students.

Vogt and Schaffner (2016) support academics employing a blended learning environment to enhance their teaching yet consideration needs to be afforded to (1) the efficacy of the activities in increasing student engagement and influencing achievement, (2) the cost of the activities, (3) the ease of implementation and (4) the ability to successfully implement the blended approach across large cohorts of students. Shaffer (2016) suggests that academics can redesign their existing resources into a blended learning format and therefore cut down on the expense and time that may be required to implement a new teaching and learning approach. A cost-benefit analysis and evaluation of teaching and learning approaches may be useful in mapping the influence of various teaching and learning approaches. To conclude, when contemplating why learning styles research matters, Biggs (2012) suggested that individuals have different cognitive processing mechanisms, and research profiling how individuals think, feel, act and consequently learn not only affords the academic increased knowledge, but opens the door to various innovative possibilities to enhance learning and performance through andragogic practice.

5.5 STUDY LIMITATIONS

Limitations of this study will now be discussed in the following areas- (1) sampling considerations, (2) statistical analysis (3) research design concerns, and (4) instrument issues.

5.5.1 Sampling Considerations

As the present study was undertaken in a single university, its external applicability to different curriculum designs or student populations may be limited. Consequently, it is difficult to predict if the concerns are echoed in like programs at other institutions. Ideally, each institution should identify its own influences of academic achievement in the bioscience education of nurses based on their specific student population, and amalgamate the data to draw appropriate inferences.

The low level of participant responses to the survey may represent a biased sample population, and therefore limit the scope of the findings, and in particular, the development of a broad range of learning support schemes for nursing students undertaking bioscience education. The participant sample constituted a convenience sample, and utilising a different form of sampling and recruitment such as face-to-face paper based surveys may have yielded a larger sample. Yet Birks et al. (2015) suggests that low response rates, are often typical when employing student surveys. Fricker (2008) suggest that employing an online survey as a sampling technique typically produces unfavourable response rates, and that due to non-responses, it is sometimes difficult to encourage participation using an online data collection survey. Fricker (2008) provided suggestions to improve response rates such as sending follow up or reminder emails and the use of monetary incentives; despite employing these suggestions in this study, the response rate remained low.

Within this study the sample size was too small for definitive conclusions to be interpreted from the data, and the sample gained may not be a true representation of the student cohort population (Fricker, 2008). The actual sample size of 39 was used for a retrospective two tailed power analyses. The recommended effect sizes used for this assessment were as follows: small (0.2), medium (0.5), and large (0.8) (Dancey & Reidy, 2014). The probability level employed for this analysis was $p<0.05$. The post hoc analyses revealed the statistical power for this study was 0.08 for the detection of a small effect, 0.32 for the detection of a medium effect and 0.66 for the detection of large effect size level. Whilst an increased sample size may have produced significant results this study was exploratory in nature and therefore a power analysis was unable to be completed prior to data collection.

5.5.2 Statistical Analysis Concerns

Due to the small sample size, numerous statistical analyses were unable to be utilised as the data did not meet the assumptions for the tests. For example Pearson's Coefficient was unable to be used as there was not a linear relationship between the variables, there were significant outliers and bivariate normality was unable to be established (Laerd Statistics, 2015b; The Odum Institute, 2015). Linear regression was unable to be performed as the data did not display multicollinearity (the substantial degree of accuracy in which one variable can be linearly predicted from another) and heteroscedasticity (the variability of a variable is unequal across a second variable used for prediction). Ordinal regression was inappropriate as the proportional odds assumption could not be tested as some categories of the dependent variables did not vary within the independent variable. The small data set therefore presented significant statistical issues and the most appropriate analysis were the tests utilised.

5.5.3 Research Design Concerns

A limitation to this study was its cross-sectional research design which may not indicate a definitive correlation between the variables as the snapshot of information obtained precludes the opportunity to explore prospective associations. Another research design may have elicited an increased sample size or added more dimensions and strength to the study. For example, a mixed method sequential explanatory design which would have used qualitative results such as student experiences in their learning of bioscience to support, explaining and add strength to the interpretation of the findings. Nonetheless, this study is a preliminary step in research expansion, and whilst the current study is not predictive, it may have future research implications in evaluating if study methodology can predict GPA as a proxy for student success (Hall, 2008).

5.5.4 Instrument Issues

The demographic questions that comprised the first section of the survey may have added further depth if they were more specific and detailed. For example, the survey asked if the participant had prior bioscience knowledge but perhaps should have also asked where this knowledge was gained. Furthermore, this learning style inventory was comprised of 80 items. The length of the instrument may have

deterred some students from participating in the study. Additionally, the instrument used in this study was limited as it relied entirely on student responses and therefore, there may be issues with inherent bias or misinterpretation of the question items. There are various learning styles frameworks, models and theories and therefore one model may be more applicable to bioscience education than another. The appropriateness and applicability of models to each educational field has not yet been determined. Indeed, there appears to be an assumption that all learning styles theories are universally applicable which may be incorrect. Furthermore, it has been discussed that numerous other individual factors, such as personal support structures, dependents, employment, and living conditions may influence student performance. Whilst this study provided a description of the andragogical problems, obtaining further detailed personal information may well improve accuracy in a subsequent predictive study.

5.6 SUMMARY

This chapter discussed the associations between student demographics, learning styles and academic achievement and provided a discussion on the relationship between these variables to current theories and to the literature reported in chapter two, literature review. The student characteristics identified were diverse, as were the learning styles employed and the resulting bioscience academic achievement. This study adds to the limited research exploring the strategies employed by nursing students in their bioscience learning. There was no association between learning styles and academic achievement, due to the limitations encountered, primarily the small sample size. Despite this limitation, significant knowledge was gained regarding the interaction of these variables. This knowledge may inform teaching practices in bioscience education by identifying the learning styles employed and providing direction for subsequent teaching models (Table 5.2). This chapter discussed this study's findings in relation to current empirical literature and considered the limitations encountered in this study. Chapter six will detail the implications and recommendations that were highlighted by this research.

Table 5.2 *What this study adds to the current literature*

What this study adds:
• Nursing student's academic success may not be influenced by inherent student characteristics, indicating other factors may influence student achievement in bioscience. • Student characteristics may not be an indication of preferred learning styles in bioscience. • Nursing students appear to use a range of learning styles in their study of bioscience concepts. • Blended teaching approaches that cater to various learning styles may need to be developed to maximise learning within the bioscience education of nursing students.

Chapter 6: Conclusions

Bioscience provides a foundation for nursing care. Indeed, nursing student comprehension of, and engagement with, bioscience concepts are vital to the development of the critical thinking skills required by this profession to provide safe care (Smales, 2010; Birks et al., 2013). Despite obvious relevance and importance, nursing students experience significant difficulties in learning and integrating this content into their clinical practice (Smales, 2010). Consequently there are concerns that students are unable to meet professional standards (McVicar et al., 2015). However, despite the well documented difficulties, little was known about the methods nursing students employ to learn bioscience. The purpose of this research was twofold. First, the learning styles employed by nursing students were identified using the Honey and Mumford LSI. Secondly the relationship between learning styles and achievement were explored. Subsequently, the relationship between the learning styles and academic achievement in the bioscience education of nursing students was examined.

This chapter highlights the major findings of this study and outlines implications and recommendations for bioscience education, research and clinical practice. Section 6.1 will provide a summary of the key findings of this study, section 6.2 will then discuss the revised conceptual model. Implications and recommendations for the bioscience education of nurses (section 6.3) and implications and recommendations for future research (section 6.4) will be discussed. Section 6.5 will detail the implications and recommendations from this study for the clinical practice environment. Finally, to conclude this thesis section 6.6 will provide a summary of concluding remarks.

6.1 KEY FINDINGS

What learning styles were adopted by nursing students in their study of bioscience subjects?

A range of learning styles was found to be employed by nursing students in their learning of bioscience concepts. The Reflector learning style was clearly the most frequent dominant style employed but Pragmatist, Theorist and multimodal

combinations, which included the Activist learning style, were evident within the nursing cohort.

Do student characteristics influence:

a) the learning styles employed; or

b) the achievement of nurses in bioscience education.

Due to increased diversity in the nursing program, students now have varying competing interests including: the need to work to support themselves and their family, consequent financial difficulties, varying social situations and cultural backgrounds (Tabi et al., 2013). This diversity has resulted in students who are time poor and require flexible culturally inclusive learning options (Tabi et al., 2013). For example, the terminology associated with learning what is perceived to be 'hard science' has been compared to learning a foreign language; this is problematic for those from non-English speaking backgrounds without appropriate support (Craft et al., 2013).

Indeed, this study appeared to indicate that nursing students are heterogeneous and vary in age, gender, non-English speaking background, cultural heritage, prior bioscience knowledge and prior healthcare experience. Notably, no statistically significant associations were found between these individual student characteristics, and either student learning styles or achievement. This appears to indicate that other factors such as the amount of time student spends engaging with content or time on task, may influence the learning styles and assessment (Johnston et al., 2015).

Does one learning style correlate with higher bioscience grade outcomes compared to others?

Schools of nursing have a professional and ethical responsibility to produce students that are highly skilled, educated, knowledgeable and competent in critical reasoning to make patient orientated decisions in a demanding healthcare environment (Ali & Naylor, 2010). Therefore, nursing schools require research to identify elements that have an influence on student achievement (Ali & Naylor, 2010). Whilst there was no correlation between the learning styles employed in bioscience and academic achievement, the most frequent dominant learning style Reflector was distributed across the demographic variables and demonstrated a mean GPA 5.69 (SD 1.09).

As multiple learning styles were employed, and none could be appropriately correlated with increased academic achievement in bioscience, a model such as a blended teaching and learning model may be the most appropriate teaching and learning approach. The teaching methods currently employed by bioscience educators appear to fail to facilitate effective learning. Learning styles knowledge has been discussed as a determinant of student learning yet the best approach to capitalise on this knowledge has been unclear with various models and subsequent tools detailed in the literature (Hallin, 2014; Kyprianidou et al., 2012; Threeton et al., 2013). The blended teaching and learning approach recognises the diversity of needs of the student cohort and the varied learning styles employed by utilising active learning principles and various learning activities to provide an optimal learning experience.

6.2 REVISED CONCEPTUAL MODEL

The conceptual model was revised based on consideration of the study results, and the key aspects identified in the literature as integral to nursing student's comprehension of bioscience concepts. As the student characteristics appeared to not statistically influence student achievement in bioscience, these elements were removed from the conceptual model (Figure 6.1). This included their perception of bioscience, their academic transition and their sociodemographic characteristics. Prior learning in bioscience was also not found to significantly influence achievement and was also removed from the model. While learning styles displayed no correlation with student achievement, learning styles has been retained in the revised conceptual framework until a larger participant pool can be sourced to empirically determine the relationship between these variables. The appropriateness and applicability of the multitude of different learning frameworks has not been explored in nursing or bioscience education; therefore, the model employed may influence student learning and is therefore retained in the revised conceptual model.

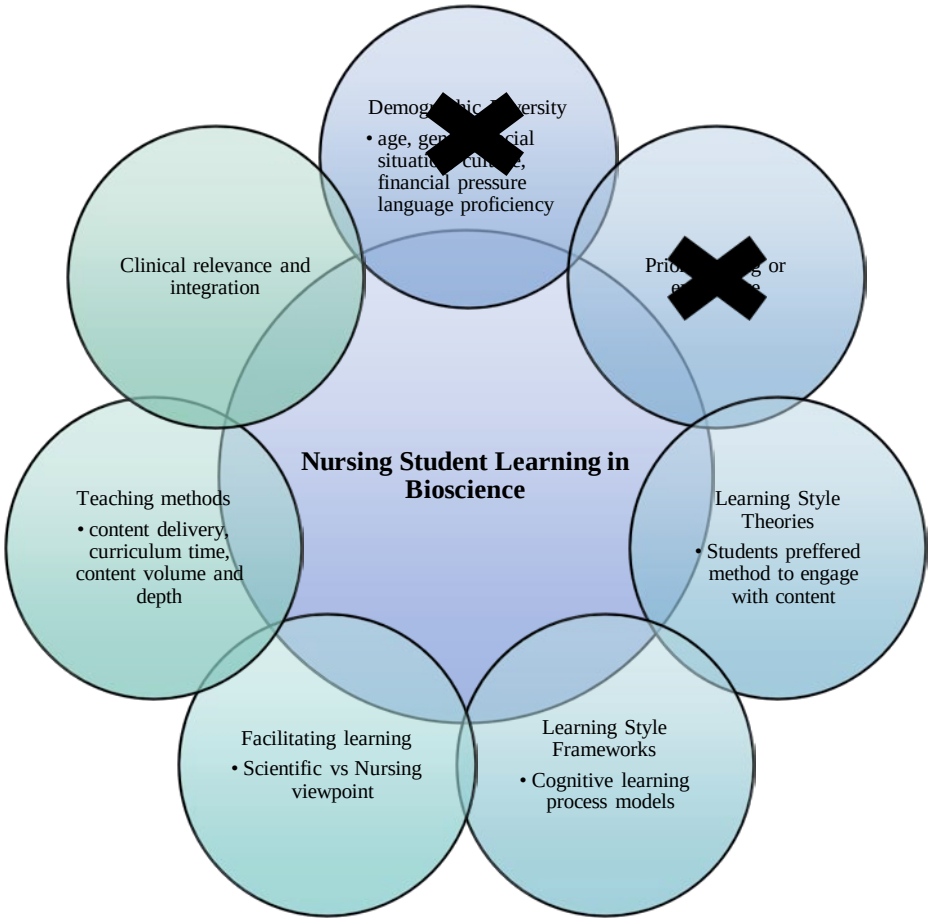


Figure 6.1 Elements altered in original conceptual model

Upon revising the conceptual model, it retained its original structure with the overlap of concepts and colour transitions indicating the interconnectedness of the elements. These elements include: 1) student learning: including the learning styles employed by nursing students and the amount of time they engage with bioscience content; 2) the education provision: including who teaches the content, how learning is facilitated the method of content delivery and teaching model employed; 3) the clinical environment: including the need for clinical relevance and integration within the education provided. Theoretically grounded conceptual models that incorporate quantitative research are needed for effective planning and management strategy (Johnson & Henderson, 2011). Therefore, the development of this model may support educators in the development of innovative teaching approaches, and student-focussed learning support strategies, within the bioscience units of the undergraduate nursing program.

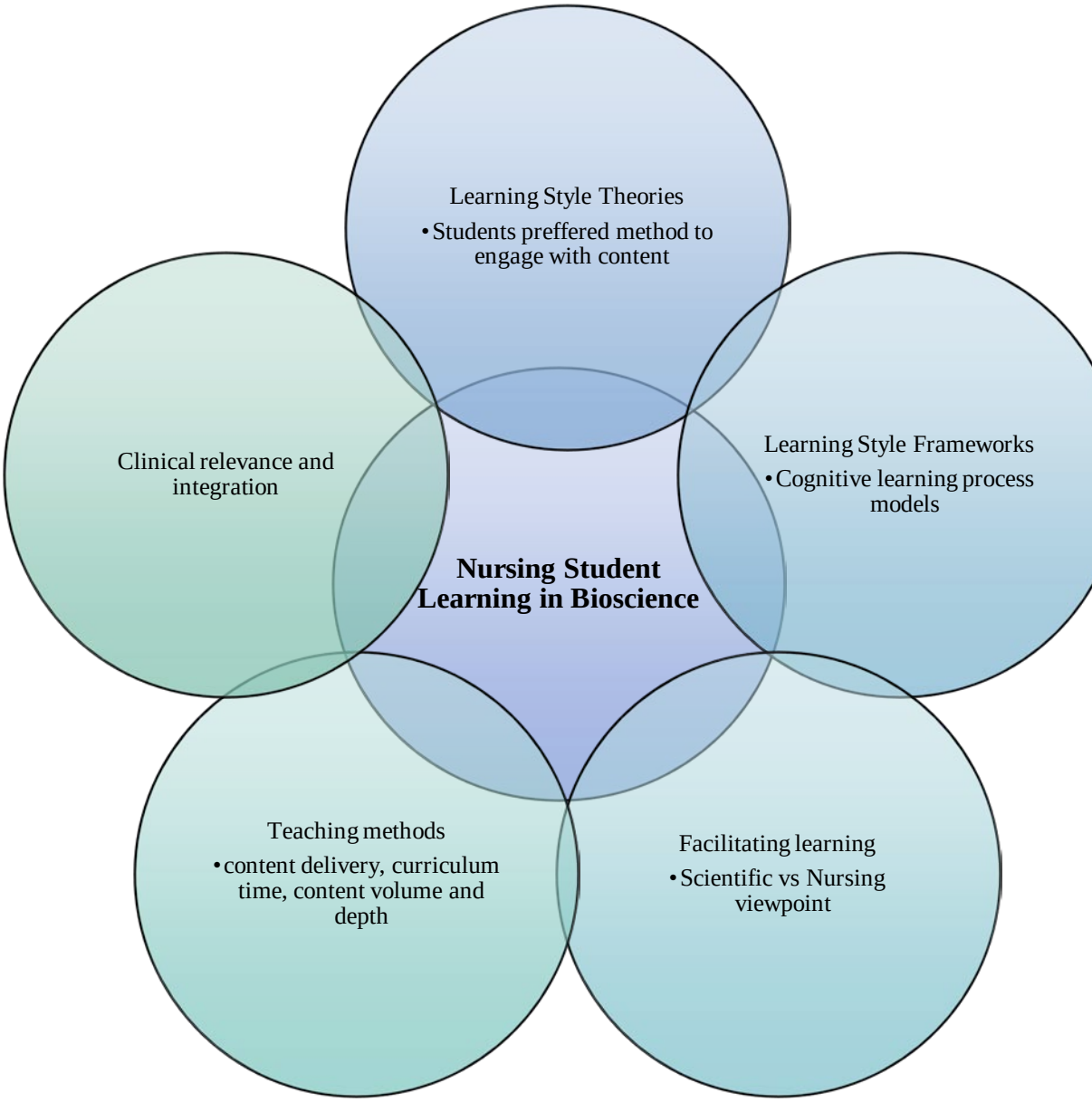


Figure 6.2 Revised conceptual model

6.3 IMPLICATIONS AND RECOMMENDATIONS FOR NURSING BIOSCIENCE EDUCATION

6.3.1 Implications for Bioscience Education in Nursing

The concern that nursing students may not be able to translate and integrate bioscience knowledge has implications for nursing program providers, as these institutions must meet the accreditations standards set out by the accrediting body (ANMAC) in their nursing program. Standard 2.4 specifically states that "*the program provider demonstrates teaching and learning approaches that facilitate the integration of theory and practice* (ANMAC, 2012, p.12)." As multiple learning styles were identified, blended teaching approaches that integrate the teaching and learning activities preferred by each learning style (Activist, Reflector, Pragmatist, and Theorist) may prove advantageous. Indeed, blended approaches may provide bioscience educators a method through which they can increase the time on task and level of engagement nursing students assign to their bioscience learning. Furthermore, development of and subsequent engagement with student support programs such as additional language support and contextualised science support for those without prior bioscience knowledge may need to be encouraged. It is important to consider the student experience and create programs that are learner centred (Lum et al., 2011). This may assist to address the difficulties nursing students experience in learning bioscience and ensure practice readiness.

6.3.2 Recommendations for Bioscience Education in Nursing

The development of an innovative and comprehensive framework incorporating the elements retained within the conceptual model that provides direction on the delivery of bioscience education to nursing students, may be beneficial. A detailed framework may provide educators with guidance on the most appropriate mechanisms in which to engage nursing students and provide contextualised bioscience theoretical learning that is therefore able to be applied to the clinical setting.

Continuous professional development of learning support staff in learning styles theory and in support strategy design may prove valuable. Furthermore, the ability of these professionals to provide context to the subject matter may be useful in meeting the needs of nursing students (Mayfield, 2012). Evaluation of the efficacy and structural delivery of these programs and their impact on the bioscience

comprehension of student nurses may also shed light on the influence of these programs and consequently their long term viability (Crawford & Candlin, 2013; McVicar et al., 2014).

6.4 IMPLICATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

6.4.1 Implications for Future Research

In this study, student characteristics did not appear to influence learning styles or academic performance and the relationship between learning styles and student achievement did not reach statistical significance; this was likely influenced by the small sample size. Thus, this study highlighted the importance of sampling methodology. Whilst online research is convenient and economical, it may fail to engage the targeted sample population even when incentives are employed (Fricker, 2008). Sample size has a direct influence on the statistical analysis techniques utilised and alternative plans for research analysis should be debated during initial research design.

6.4.2 Recommendations for Future Research

From this research, recommendations for the direction of future studies into the teaching and learning of nursing students in bioscience include: (1) the replication of this study with adequate power including an increased sample size, (2) exploration and inclusion of alternative variables that may influence student performance, and (3) the collection of data at multiple universities both domestically and internationally to increase the transferability of the results (Johnston et al., 2015; Newton et al., 2007). This knowledge may be a valuable resource in identifying student's educational needs, which in turn may lead to more effective and engaging teaching, and learning support programs. Furthermore, evaluating how bioscience is incorporated into post-graduate learning in healthcare may provide a stimulus for further development of alternate teaching strategies.

6.5 IMPLICATIONS AND RECOMMENDATIONS FOR CLINICAL PRACTICE

6.5.1 Implications for Clinical Practice

Davis (2010) states quite clearly that the problems within the teaching and learning of bioscience has led to nurses with a lack of preparation and consequent

ability to meet the responsibilities and professional expectations required for the role of the Registered Nurse. This deficit may have serious implications on the student's ability to ensure patient safety and positive health outcomes. Therefore, with consideration of the skills and competencies that underpin nursing care, a method of embedding bioscience content into nursing assessment methods may assist students in meeting learning outcomes and transferring this knowledge into the clinical environment (Mayne, 2012). Ongoing cross-disciplinary dialogue between industry experts and nursing educators within universities may create awareness of current professional expectations (Mayne, 2012).

6.5.2 Recommendations for Clinical Practice

Clearer articulation of the specific knowledge required by both the ANMAC and professional nursing bodies and the clinical environment, may assist with curriculum development that can allow the integration and facilitation of bioscience theory into current clinical practice. Further education and promotion of the importance of bioscience concepts to established Registered Nurses within the clinical environment may promote evidenced-based care that considers a holistic physical assessment. If established Registered Nurses are able to articulate bioscience concepts relevant to their practice, they may then be more confident in educating student nurses and facilitating the integration of theoretical bioscience concepts into their nursing practice.

6.6 SUMMARY

This study aimed to explore the current nursing student cohort demographics as a determinant of learning styles that may influence the learning processes of undergraduate nursing students. The research objectives included (1) to explore the different learning styles employed, (2) to identify if student characteristics influenced learning styles and achievement, and (3) ascertain if learning styles influenced achievement. The gaps in the knowledge were identified from an integrative literature review which informed the research objectives and the underpinning research aim.

A quantitative cross-sectional study design permitted the accurate collection of variables and data to be collected, analysed and then interpreted. The theoretical and empirical literature informed the selection of variables and instrumentation used to

measure the dependent variables. The findings of this study indicated that student learning appears to be multifaceted, with the literature debating those variables that may or may not influence the learning process. It was suggested in the literature that there may have been a relationship between student characteristics and their learning styles then resultantly a relationship between their learning styles and academic achievement. Therefore, demographic data was collected and learning styles were determined through the use of a validated instrument. This information was correlated with student achievement.

Despite the empirical literature surrounding the study's research objectives, the results from this study were not statistically significant. The outcome of this study demonstrated that the influences of student learning styles on the academic achievement of nursing students in bioscience may not be fully understood. The words of Albert Einstein (1879-1955) *"I never teach my pupils, I only provide the conditions in which they learn,"* conveys the importance of importance of understanding how students learn and the cognitive processes behind learning, integrating and applying knowledge. Lifelong learning is a core theme in nursing, and optimising the learning process at the beginning of the student's engagement with the profession will serve to ensure not only the positive health of patients but will advance the knowledge and career trajectory of the student. The implications of this study on the bioscience education of nurses, continuing research and the clinical environment have been discussed with recommendations made to highlight future directions.

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Appendices

Appendix A: Table 6.1 Articles included after Critical Appraisal

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
VI	1. Alkella	2010	Evaluation	Reflective educator perspective in the USA	Kolb's model stimulates students and challenges them to develop necessary skills for effective thinking and problem solving.	Include	Two
IV	2.Alkhasawneh, Mrayyan, Docherty Alashram & Yousef	2008	Interventional Study	92 nursing students in Jordan	Most students are able to learn effectively if the educator provides learning activities in various styles utilising active learning techniques such as PBL, demonstrations, discussions and answering questions. 68% of students indicated multimodal preferences for learning.	Include	Two
V	3. Andreou, Papastavrou & Merkouris	2014	Systematic Review	Six descriptive correlational studies from international sources	Learning styles are a reflection of habitual behaviour which demonstrate learning preferences. Learning styles can be a positive determinant of critical thinking.	Include	Two

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
IV	4.Andrew, McVicar, Zanganeh & Henderson	2015	Prospective Correlational Survey	26 Surveys of nursing students in the UK	Academic success, confidence, previous science and perceiving bioscience as relevant to nursing are interwoven concepts.	Include	One
V	5.Amaro, Abriam-Yago & Yoder	2006	Grounded theory	17 Registered Nurses in the USA	Nursing students struggle with a lack of finances, time, family responsibilities and the language required.	Include	One
V	6.Bakon, Craft, Christensen & Wirhana	2015	Review	26 papers	Increased bioscience knowledge improves patient care therefore addressing the bioscience problem through innovative use of assessment is integral.	Include	One
IV	7.Béres, Magyar & Turcsányi-Szabó	2012	Mixed Methods Study	101 university students in Lithuania	This research found that students choose teaching approaches that align with their learning style regardless of the learning style framework employed.	Include	Two

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
V	8.Bhatti & Bart	2013	Survey	101 university students from the USA	Students in a particular cohort can possess a dominant learning style and this style can influence GPA (p=0.036).	Include	One
VII	9.Biggs	2012	Discursive		The learning process is a method of interacting with the world and as we internalise new knowledge into our existing cognitive matrix we reorganise the information and use it to build a new conceptual understanding.	Include	Two
VI	10.Birks, Cant, Al-Motlaq & Jones	2011	Descriptive, Exploratory Survey	69 Nursing students from a University in Australia	Increasing an appreciation of the relevance of course content will enhance the students' experience. Yet students (31.9%) indicate that they find bioscience unenjoyable.	Include	One
VII	11.Blevins	2014	Discursive	USA	Our individual differences including our age, sex and culture can impact on the way adult students learn and their learning style.	Include	Two

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
VII	12.Cegielski, Hazen & Rainer	2011	Specific Complementary Instructional	196 students in the USA	Coordination of an appropriate teaching method that mirrors the students learning style may enhance measurable outcomes in their education. Visual learners learn better with visual based instruction (p=<0.001),	Include	Two
VI	13.Charlesworth	2008	Questionnaire	113 students of varying ethnicity in the UK	There were moderate differences between learning style preferences between Indonesian, Chinese and French students (Activist *f=0.30* Reflector *f=0.33*, Pragmatist *f=0.24*).	Include	Two
VI	14.Christensen, Craft, Wirihana & Gordon	2015	Questionnaire	43 nursing students in Australia	Student nurses (90%) value the depth of knowledge provided by a bioscientist, but requires team-based teaching to contextualise the theory.	Include	One

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
IV	15.Colville, Cottom, Robinette, Wald & Waters	2015	Cross Sectional Analysis	308 nursing students in the USA	Nursing culturally diverse and students from various cultural backgrounds may need targeted support mechanisms to enhance their learning. As this was shown to increase student achievement by 17.2%.	Include	One
IV	16.Craft, Hudson, Plenderleith, Wirihana & Gordon	2013	Quantitative Questionnaire Design	273 nursing students in Australia	Prior bioscience learning was seen as an advantage to nursing students (p=0.01). Increasing age increased exam anxiety (p=0.00). Students report finding bioscience difficult to learn (p=0.02).	Include	One
V	17. Davis	2010	Mixed Methods-Questionnaire & Interview	42 Registered Nurses in the UK	57% of RNs felt there was not enough bioscience covered in their undergraduate program and 40.5% felt that the bioscience did not prepare them for their role.	Include	One

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
VII	18.Efstathiou & Bailey	2012	Evaluation	110 nursing students in the UK	87% of students liked the use of innovative technology such as ARS as a teaching resource.	Include	One
V	19.Felder & Brent	2005	Review	-	Understanding student differences poses implications for teaching and learning approaches. There are many different views regarding learning, cognitive function and student differences.	Include	One
IV	20.Fleming, Mckee, & Huntley-Moore	2011	Longitudinal Study	58 nursing students in Ireland	The most common learning style was a dual learning category (35%) Therefore nurse educators need to be aware of their students learning styles.	Include	Two
IV	21.Fogg, Carlson-Sabeli, Carlson & Giddens	2013	Comparative	350 nursing students in five states in the USA	Ethnicity influences learning style as assimilators were predominantly African American (p=.001) Divergers- Asian American (p=.000) Convergers- White (p=.004) and accommodators Hispanic (p=.006).	Include	One

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
IV	22.Hallin	2014	Descriptive Cross-Sectional Study	263 nursing student from rural Sweden	Educators need variation and interactive teaching approaches and conscious learning strategies for nursing students.	Include	Two
VI	23.Holtbrugge & Mohr	2010	Questionnaire	939 students at multiple international universities	Learning style preferences can be influenced by culture.	Include	Two
VI	24.Hung	2012	Quasi- Experimental Post Test	98 students in Taiwan	A significant two-way interaction was found between learning style orientation and teaching method (post-test) for the program design performance tests: F= 8.784, p= 0.000	Include	Two
IV	25.James, D'Amore & Thomas	2011	Cross-sectional Survey	334 nursing and midwifery students in Australia	80% of nursing students were multimodal learners.	Include	Two

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
IV	26.Joy & Kolb	2009	Quantitative	533 respondents from 7 countries.	Individual demographics influence the learning style and methods employed by students in their learning.	Include	One
VI	27.Kappe, Boekholt, den Rooyen & Van der Flier	2009	Questionnaire	99 students from the Netherlands	The Honey and Mumford LSI is not a psychometric instrument; it's a self-development tool. Test–retest reliabilities for the four subscales, over the two year period, were: Activists (r = .70), Reflectors (r = .63), Theorists (r = .50), and Pragmatists (r = .46).	Include	Two
IV	28.Koch, Everett, Phillips & Davidson	2014	Web Based Survey	704 nursing students and 165 nursing faculty from 7 Australian universities.	Appropriate development and academic support is needed for the diverse student cohort.	Include	One
VI	29.Kyprianidou, Demetriadis, Tsiatsos & Pombortsis	2012	Qualitative Design	50 university students in Greece	Adoption of learning styles theories in practice can be facilitated.	Include	Two

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
VI	30.Li, Chen & Tsai	2008	Descriptive Exploratory Design	425 nursing students from Taiwan	Identifying students' learning styles allows educators to efficiently teach a diverse populace of students.	Include	Two
VI	31.Li, Yu, Liu, Shieh, & Yang	2014	Descriptive Exploratory Design	285 nursing students in Taiwan	Academic performance can be appropriately linked to nursing students learning style.	Include	Two
IV	32.Mayfield	2012	Pilot Study	51 nursing students in the USA	Students can maximize their knowledge using their learning style.	Include	Two
IV	33.McCrow, Yevchak & Lewis	2014	Questionnaire	1250 Registered Nurses in Australia	Learning style varies across the nursing cohort- active/reflective (n = 77, 54%), sequential/global learning (n = 96, 68%) reflective (n = 21, 15%), intuitive (n = 5, 4%), verbal (n = 11, 8%) or global learning (n = 15, 11%).	Include	Two

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
VII	34.McKinnon	2009	Program Evaluation	-	Nursing is an increasingly complex occupation where highly educated staff are needed to provide safe patient care.	Include	Two
VI	35.McVicar, Clancy & Mayes	2010	Mixed Methods	19 Registered Nurses in the UK	Bioscience is viewed by nurses as important yet it is one of the most difficult subjects for nurses to learn.	Include	One
V	36.McVicar, Andrew & Kemble	2014	Review	14 papers	There are numerous barriers to teaching bioscience to nurses, such as the lack of a student-focussed teaching approach.	Include	One
V	37.McVicar, Andrew & Kemble	2015	Review	19 papers	Individual student factors including age, study skills and scientific background may influence student success.	Include	One

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
IV	38.Meehan-Andrews	2009	Quantitative Questionnaire	230 students in allied health programs in Australia	Students may employ multiple learning styles. For example 20% preferred 2 modes 10% preferred 3 modes and 16% preferred 4 modes, 54% preferred a single mode of information presentation.	Include	Two
VII	39.Miller	2010	Reflective Discussion	-	Nursing students are often confused by medical jargon.	Include	One
V	40.Romanelli, Bird & Ryan	2009	Review	-	Learning style literature has become a significant concept as both diversity and university class sizes increases.	Include	Two
IIV	41.Searson & Dunn	2001	Cohort Study	53 students	Tactual or kinaesthetic teaching and learning methods are optimal for increasing understanding in science based units	Include	Two

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
VI	42.Sinclair & Ferguson	2009	Mixed- Methods	250 nursing students in Canada	Nursing students felt increased satisfaction when exposed to various learning that aligned with their learning style.	Include	Two
VII	43.Smales	2010	Discursive	-	Nursing students have difficulty in applying bioscience knowledge to clinical practice.	Include	One
VI	44.Tabi, Thornton, Garno & Rushing	2013	Descriptive Exploratory	46 nursing students from the USA	Universities need to support diversity and provide programs that enhance academic success.	Include	One
IV	45.Taylor, Ashelford, Fell & Goacher	2015	Mixed Method Survey	22 nurse educators from 10 institutions in the UK	There are concerns regarding the lack of time allocated to teaching bioscience in the nursing degree. Patient safety and nurse competence requires an understanding of bioscience.	Include	One

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP	Analytical Theme
VI	46.Tinajero, Lemos, Araújo, Ferraces & Páramo	2012	Questionnaire	313 university students in Brazil	Cognitive style and or learning strategy can considerably contribute to academic achievement.	Include	Two
VI	47.Threeton, Walter & Evanoski	2013	Quantitative Survey	310 university students in the USA	There is a relationship between teaching methods and student learning.	Include	Two
V	48. Whyte, Madigan & Drinkwater	2011	Quantitative	543 nursing and paramedic students	Individual student factors can be used to predict bioscience success. Previous study in biology increased students achievement in bioscience (p=.03)	Include	One
IV	49.Wu et al.	2010	Mixed Methods	409 nursing student in the USA	Critical thinking in nursing improves as the nursing degree progresses. Simulation learning experiences appear to be beneficial.	Include	One
IV	50.Wilkinson, Boohan & Stevenson	2014	Survey	276 medical students in Ireland	Honey and Mumford's Learner Typology was built on Kolb's experimental learning cycle.	Include	Two

Appendix B: Table 6.2 Condensed Data Extraction

Analytical theme 1	Descriptive themes	Coding	Word/phrase
The Bioscience Teaching and Learning Problem	Clinical Relevance and Integration	RE	Need to study biosciences, clinical value of learning bioscience, Relevance and its relationship with bioscience remains a persistent issue in healthcare disciplines, relevance has not only been questioned by students but also by academics and clinicians, an appreciation of the significance of content may enhance the experience.
		RN	Biosciences should be key contributors to nursing, fundamental, expanding scope of practice, increasing autonomy of nurses make it essential for nurses to have a sound biological knowledge.
		RP	Applying this knowledge to practice improves their understanding and efficacy, situations of rapid change and physiological instability nurses need to draw on bioscience-based knowledge.
		RE	Development of proficient practitioners.
	Demographic Diversity	ED	Anxiety, stress, feelings of inadequacy, lack confidence, loneliness, isolation, perceptions, weak.
		AD	Disproportionate difficulty, academic aptitude
		TD	Time consuming, time constraints, academic, financial pressures
		DD	Mature entry, previously studied biology, prior clinical experience, student demographics and educational backgrounds, lack foundational knowledge.
		CD	Diverse, heterogeneous, English language proficiency.
		LD	Language and terminology difficult.

Analytical theme 1	Descriptive themes	Coding	Word/phrase
The Bioscience Teaching and Learning Problem	Facilitating Learning	NK	Lecturers are inadequately prepared, bioscientist background have difficulty in simplifying the subject.
		PK	Prefer to learn bioscience when the knowledge is related to clinical practice, lack of sufficient linking of bioscience teaching to practice, related to experiences in their workplace, apply theoretical bioscience concepts to clinical practice.
		RK	Educators lack of understanding of the complexity of the role of the nurse in practice.
		BK	Insufficient preparation in biosciences, educators' may not have sufficient science background.
		FK	Biomedical model, nursing moved away from its medical dominance, clinical reasoning cycle, confidence in knowledge application and critical thinking.
		CK	Apparent lack of consensus on content and depth, heavy workload.
	Teaching Methods	TR	Teaching affects student ability, integration, achievement, comprehension, engagement.
		TC	Economical.
		TI	Inconsistencies in the educational instruction, inadequate curriculum, curriculum time.
		TF	Mode, active learning principles, passive.
		TM	Lectures, tutorials, laboratory, workshops, online, web-based, e-learning, materials, resources, lectures may be a poor choice, learning environment, content delivery.
		TE	Lack experiences, information exchange, facilitate the continuing education.

Underpinning Teaching and Learning Theories	**Integrating Learning Style Knowledge**	SI	Is learning style is important?
		SS	Meeting learning needs.
		ST	Adaptive teaching strategies, strategy identification, delivery, engagement and assessment, improve teaching practices.
		SM	Congruency, matching educational styles.
		SA	Rapid rate of comprehension, increased understanding, , integrate and appropriately utilise.
		SP	Improved performance, academic performance.
		SE	Increased educational satisfaction, learning experience.
	Learning Style Theories	LF	Cognitive, cultural, individual and environmental student, preconceptions, personality, past experiences and cognitive processes, values, attitudes and interactions, interact, internalise.
		LK	Mode that is effective and conducive, educational assets and flaws, predict, student success, andragogical methods, capitalise on these differences.
		LI	Differing definitions, background or perspectives, effective/ineffective educational instruction.
		LE	Learning environments, environmental conditions.
		LS	Learns best, psychological manifestation of the learning environment, cognitive psychosocial demographics; reflect habitual behavioural preferences.
Analytical theme 2	**Descriptive Themes**	**Coding**	**Word/phrase**

Underpinning Teaching and Learning Theories	**Learning Style Frameworks**	FV	Different learning style models, frameworks, theories.
		FT	VARK, MBTI, Kolbs Experimental Learning Cycle, Honey and Mumford's LSI.
		FT	Guiding teaching, capitalizing on learning.
		FF	Psychometric properties, perception and judgment, assumption, personality preference, circular process, four dimensions of learning,
		FR	Modal preferences, multimodal learner, dominant,
		FA	Transparency, validity and reliability, flexible,
		SD	Develop, innovative.
		SL	Learning, student performance, retention, environment, Comprehension, failure, experience, cohort characteristics
		ST	Models, methods, modes, resources, approaches
		SP	Universities, institutions, facilities, standards, provider, disciplines.
Analytical theme 2	**Descriptive themes**	**Coding**	**Word/phrase**

Appendix C: Recruitment Email

A Quantitative Investigation into the Relationship between Nursing Students' Learning Style and Success in Bioscience Education.

Dear Nursing students

My name is Shannon Bakon from School of Nursing and I'm doing a Masters in Applied Science Research looking into the correlation between student learning style and academic achievement.

If you'd like to help me in this study I'm looking for first year second semester, second and third year full time nursing students who commenced a standard course enrollment in Course NS40 at Kelvin Grove and Caboolture QUT campuses. These students will have completed at least one unit of nursing bioscience education. These units include Bioscience 1 (LSB182), Bioscience 2 (LSB282), Bioscience 3 (LSB382), and Understanding Disease Concepts (LSB111). I will need participants to complete a 20 minute online survey.

Please view the attached Participant Information Sheet for further details on the study and follow the link to access the survey.

http://survey.qut.edu.au/f/185385/8d06/

Should you have any questions, please contact me via email.

Please note that this study has been approved by the QUT Human Research Ethics Committee (approval number 1500000869).

Many thanks for your consideration of this request.

Shannon Bakon RN BN
Masters Student
5316 7621
s.dhollande@hdr.qut.edu.au

Associate Professor Martin Christensen
Principal Supervisor
5316 7508
martin.christensen@qut.edu.au

School of Nursing, Faculty of Health
Queensland University of Technology

Appendix D: Participant Information Sheet

PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT

A Quantitative Investigation into the Relationship Between Nursing Students' Learning Style and Success in Bioscience Education

Ethical approval number 1500000869

RESEARCH TEAM

Principal Researcher:	Shannon Bakon RN BN	Masters Student
Associate Researchers:	Associate Professor Martin Christensen	Principal Supervisor
	Dr Judy Craft	Associate Supervisor

School of Nursing, Faculty of Health, Queensland University of Technology (QUT)

DESCRIPTION

This project is being undertaken as part of a Masters of Applied Science Research Degree.

Before you decide if you are going to participate it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Contact us if there is anything that is not clear or if you would like more information contact details can be found at the end of this sheet. Please take time to decide whether or not you wish to take part.

The purpose of this research is to explore any relationships between the learning styles of nursing students, grade outcomes in the biosciences and demographic information.

You are invited to participate in this project because you are a second or third year full time nursing student who commenced a standard course enrolment in Course NS40 at Kelvin Grove or Caboolture QUT campuses. You will also have completed at least one unit of nursing bioscience education. These units include Bioscience 1 (LSB182), Bioscience 2 (LSB282), Bioscience 3 (LSB382), and Understanding Disease Concepts (LSB111).

PARTICIPATION

Participation will involve completing an online survey that will take approximately 20 minutes of your time.

The first question will ask you to provide consent for a QUT administrative staff member to access your bio-science grades. You will then be asked questions about your age, gender, cultural identity, marital status and highest educational qualification prior to commencing the nursing degree. The remainder of the survey will focus on questions around learning style.

You will be asked to indicate whether you agree/disagree with questions such as:

- I have strong beliefs about right/wrong, good and bad
- I tend to solve problems using a step by step approach
- I believe that formal procedures and policies tend to restrict people

Completion of the survey indicates that they have read and understood the information about the study including the provision of their consent to access GPA records and thus agree to participate in the research. The survey will be de-identified once the survey results have been compared to unit outcomes. If you do agree to participate you can withdraw from the project by simply not submitting

the survey – the incomplete survey will be discarded from the analysis stage of the study. Once the survey is submitted you will not be able to withdraw from the study. Your participation in this project is entirely voluntary. Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT or your progression within the nursing program or future employment.

EXPECTED BENEFITS

Whilst it is expected that this project may not directly benefit you, it is expected findings from this study will guide the development of future nursing bioscience curricula.

To recognize your contribution should you choose to participate the research team is offering you the chance to go into a prize draw for a $200.00 Westfield Shopping Gift Card. All participant student numbers will be placed in the draw. A student number will be randomly selected prior to de-identification of the surveys and this student will be notified by emailed by QUT Nursing administration to organize prize collection. The draw runs March 1, 2016 to June 1, 2016. The winning student will be notified by 1 June 2016.

RISKS

The research team does not believe there are any risks beyond normal day-to-day living associated with your participation in this research.

PRIVACY AND CONFIDENTIALITY

All data will remain confidential. Only the researcher's will have access to the data and the data they receive will not be identifiable. An independent nursing administrative officer will receive the responses and match these with your GPA, then return the data to the researchers without your student number ensuring you remain anonymous. Following data analysis and prize draw notification any identifying information will be removed. Data will be stored as non-identifiable. Data collected as part of this project will be stored securely as per QUT's Management of Research Data Policy.

Please note that non-identifiable data collected in this project may be used as comparative data in future projects or stored on an open access database for secondary analysis.

CONSENT TO PARTICIPATE

You will be asked on the survey to consent to a Nursing administration officer accessing your bio-science grades.
Completion of the online survey will indicate consent for the survey data to be used in this project.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If have any questions or require further information please contact one of the researchers listed below.

Shannon Bakon	07 5316 7621	s.dhollande@hdr.qut.edu.au
Martin Christensen	07 5316 7508	martin.christensen@qut.edu.au

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on 07 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information.

Appendix E: Ethical Approval

University Human Research Ethics Committee (UHREC)

HUMAN RESEARCH ETHICS APPROVAL CERTIFICATE

NHMRC Registered Committee Number EC00171

Date of Issue: 23/3/16 (supersedes all previously issued certificates)

Dear A/Prof Martin Christensen

This approval certificate serves as your written notice that the proposal has met the requirements of the *National Statement on Ethical Conduct in Human Research* and has been approved on that basis. You are therefore authorised to commence activities as outlined in your application, subject to any specific and standard conditions detailed in this document.

Project Details

Category of Approval:	Negligible-Low Risk		
Approved From:	6/11/2015	**Approved Until:** 6/11/2017	(subject to annual reports)
Approval Number:	1500000869		
Project Title:	A quantitative investigation into the relationship between nursing students' learning style and success in bioscience education		

Investigator Details

Chief Investigator: A/Prof Martin Christensen

Other Staff/Students:

Investigator Name	Type	Role
Mrs Shannon Bakon	Student	Masters (Research)
Dr Judy Craft	Internal	QUT Associate Supervisor

Conditions of Approval

Specific Conditions of Approval:
No special conditions placed on approval by the UHREC. Standard conditions apply.

Standard Conditions of Approval:

1. Conduct the project in accordance with QUT policy, the ***National Statement on Ethical Conduct in Human Research*** (http://www.nhmrc.gov.au/guidelines/publications/e72), the ***Australian Code for the Responsible Conduct of Research*** (http://www.nhmrc.gov.au/guidelines/publications/r39), any associated legislation, guidelines or standards;
2. Gain UHREC approval for any proposed variation (http://www.orei.qut.edu.au/human/var/) to the project **prior** to implementation;
3. Respond promptly to the requests and instructions of UHREC;
4. Declare all actual, perceived or potential conflicts of interest;
5. Immediately advise the Office of Research Ethics and Integrity (http://www.orei.qut.edu.au/human/adv/) if:
   - any unforeseen development or events occur that might affect the continued ethical acceptability of the project;
   - any complaints are made, or expressions of concern are raised, in relation to the project;
   - the project needs to be suspended or modified because the risks to participants now outweigh the benefits;
   - a participant can no longer be involved because the research may harm them; and
6. Report on the progress of the approved project at least annually, or at intervals determined by UHREC. The Committee may also choose to conduct a random audit of your project.

If any details within this Approval Certificate are incorrect please advise the Research Ethics Unit within 10 days of receipt of this certificate.

Appendix F: Survey

Demographic Questions
Section A:

1. Do you consent to a professional staff member accessing your student grades for the bioscience units for the purpose of this research? If yes please provide your student number in the comments section: Please note that after correlation occurs your survey will be de-identified to preserve your confidentiality and anonymity.

   Yes

   No

Section B:

1. Do you identify as: Male or Female
2. Please select your age range: 15-20
   21-25
   26-30
   31-35
   36-40
   41-45
   46+
3. Do you come from a non-English speaking background?
4. Do you identify as: Aboriginal
   Torres Strait Islander
   Caucasian
   Other: please comment
5. What QUT Campus do you study nursing at?
6. Did you study any type of science before commencing you Bachelor of Nursing Degree? (E.g. physics, chemistry, biology at High school)

   Yes

   No
7. Do you or have you previously been employed in the health care industry?

   Yes

   No

Section C:
Honey and Mumford's Learning Style Inventory 80 Item Version

The Honey and Mumford's Learning Style Inventory is designed to find out your preferred learning style(s). Over the years you have probably developed learning "habits" that help you benefit more from some experiences than from others. Since you are probably unaware of this, this inventory will help you pinpoint your learning preferences so that you are in a better position to select learning experiences that suit your style and have a greater understanding of those that suit the style of others. There is no time limit to this inventory. It will probably take you 20 minutes. The accuracy of the results depends on how honest you can be. There are no right or wrong answers.

Be sure to indicate agree or disagree to each item

- I have strong beliefs about what is right and wrong, good and bad
- I often act without considering the possible consequences
- I tend to solve problems using a step-by-step approach
- I believe that formal procedures and policies restrict people
- I have a reputation for saying what I think, simply and directly
- I often find that actions based on feelings are as sound as those based on careful thought and analysis
- I like the sort of work where I have time for thorough preparation and implementation
- I regularly question people about their basic assumptions
- What matters most is whether something works in practice
- I actively seek out new experiences
- When I hear about a new idea or approach I immediately start working out how to apply it in practice
- I am keen on self-discipline such as watching my diet, taking regular exercise, sticking to a fixed routine, etc.
- I take pride in doing a thorough job
- I get on best with logical, analytical people and less well with spontaneous, "irrational"
- I take care over the interpretation of data available to me and avoid jumping to conclusions
- I like to reach a decision carefully after weighing up many alternatives
- I'm attracted more to novel, unusual ideas than to practical ones
- I don't like disorganised things and prefer to fit things into a coherent pattern
- I accept and stick to laid down procedures and policies so long as I regard them as an efficient way of getting the job done
- I like to relate my actions to a general principle
- In discussions I like to get straight to the point
- 1 tend to have distant, rather formal relationships with people at work
- I thrive on the challenge of tackling something new and different
- I enjoy fun-loving, spontaneous people

- I pay meticulous attention to detail before coming to a conclusion
- I find it difficult to produce ideas on impulse
- I believe in coming to the point immediately
- I am careful not to jump to conclusions too quickly
- I prefer to have as many resources of information as possible - the more data to think over the better
- Flippant people who don't take things seriously enough usually irritate me
- I listen to other people's points of view before putting my own forward
- I tend to be open about how I'm feeling
- In discussions I enjoy watching the manoeuvrings of the other participants
- I prefer to respond to events on a spontaneous, flexible basis rather than plan things out in advance
- I tend to be attracted to techniques such as network analysis, flow charts, branching programs, contingency planning, etc.
- It worries me if I have to rush out a piece of work to meet a tight deadline
- I tend to judge people's ideas on their practical merits
- Quiet, thoughtful people tend to make me feel uneasy
- I often get irritated by people who want to rush things
- It is more important to enjoy the present moment than to think about the past or future
- I think that decisions based on a thorough analysis of all the information are sounder than those based on intuition
- I tend to be a perfectionist
- In discussions I usually produce lots of spontaneous ideas
- In meetings I put forward practical realistic ideas
- More often than not, rules are there to be broken
- I prefer to stand back from a situation
- I can often see inconsistencies and weaknesses in other people's arguments
- On balance I talk more than I listen
- I can often see better, more practical ways to get things done
- I think written reports should be short and to the point
- I believe that rational, logical thinking should win the day
- I tend to discuss specific things with people rather than engaging in social discussion
- I like people who approach things realistically rather than theoretically
- In discussions I get impatient with irrelevancies and digressions
- If I have a report to write I tend to produce lots of drafts before settling on the final version

- I am keen to try things out to see if they work in practice
- I am keen to reach answers via a logical approach
- I enjoy being the one that talks a lot
- In discussions I often find I am the realist, keeping people to the point and avoiding wild speculations
- I like to ponder many alternatives before making up my mind
- In discussions with people I often find I am the most dispassionate and objective
- In discussions I'm more likely to adopt a "low profile" than to take the lead and do most of the talking
- I like to be able to relate current actions to a longer term bigger picture
- When things go wrong I am happy to shrug it off and "put it down to experience"
- I tend to reject wild, spontaneous ideas as being impractical
- It's best to think carefully before taking action
- On balance I do the listening rather than the talking
- I tend to be tough on people who find it difficult to adopt a logical approach
- Most times I believe the end justifies the means
- I don't mind hurting people's feelings so long as the job gets done
- I find the formality of having specific objectives and plans stifling
- I'm usually one of the people who puts life into a party
- I do whatever is expedient to get the job done
- I quickly get bored with methodical, detailed work
- I am keen on exploring the basic assumptions, principles and theories underpinning things and events
- I'm always interested to find out what people think
- I like meetings to be run on methodical lines, sticking to laid down agenda, etc.
- I steer clear of subjective or ambiguous topics
- I enjoy the drama and excitement of a crisis situation
- People often find me insensitive to their feelings

Appendix G: Prize Draw Terms and Conditions

Terms and Conditions of Entry into a Prize Draw

1. The Promoter is Queensland University of Technology ABN 83 791 724 622 (QUT) having its principal place of business at 2 George Street, Brisbane, Queensland 4000.
2. By entering the competition connected to the research project named in the attached Participant Information and Consent Form, participants agree to be bound by these Terms and Conditions.
3. Submitting a survey fulfils the conditions of entry into the competition.
4. The opening and closing dates of the competition are listed on the attached Participant Information Sheet and Consent Form. The prize winner will be selected by random draw which will take place at the Queensland University of Technology on the prize draw date as listed in the attached Participant Information Sheet and Consent Form.
5. The first entry drawn randomly will receive the prize listed on the attached Participant Information Sheet. The prize is not transferable, refundable, and exchangeable and cannot be taken as cash.
6. The Promoter will use reasonable efforts to notify the prize winner by no later than two weeks post the prize draw date. If a winner cannot be contacted or refuses the prize it will be offered to the next randomly drawn entry. The promoter's decision is final as to the winner of the prize and binding and no correspondence will be entered into in relation to the conduct of the competition or otherwise.
7. The prize will be available for collection by the winner at a time organised as suitable for the winner.
8. If this competition is interfered with in any way or is not capable of being conducted as anticipated due to any reason beyond reasonable control of the Promoter, the Promoter reserves the right, in its sole discretion, to the fullest extent permitted by the law to (a) disqualify any participant; or (b) subject to any written directions from a regulatory authority, to modify, suspend, terminate or cancel the competition, as appropriate.
9. All entries become the property of the Promoter and will not be returned to participants.
10. Except for any liability that cannot be excluded by law, the Promoter (including its officers, employees and agents) excludes all liability (including negligence), for any personal injury or any loss or damage (including loss of opportunity), whether direct, indirect, special or consequential, arising in any way out of the competition ,including but not limited to, where arising out of the following: (a) any technical difficulties or equipment malfunction (whether or not under the Promoter's control); (b) any theft, unauthorised access or third party interference; (c) any entry or prize claim that is late, lost, altered, damaged or misdirected (whether or not after their receipt by the Promoter) due to any reason beyond the reasonable control of the Promoter; (d) any variation in prize value to that stated in these Terms and Conditions; (e) any tax liability incurred by a winner or entrant; or (f) use of the prize.
11. Each participant indemnifies and keeps indemnified the Promoter against all claims, losses, damages and expenses suffered by the Promoter or any third parties arising out of the breach of these Terms and Conditions by the participant, the conduct of the participant in the competition, the use of information supplied by the participant or the use of the prize.
12. Under the applicable Privacy Laws, the Promoter must tell participants when it collects personal information about them and how it plans to use it. lf a participant chooses to enter or take part in the competition, the participant will be required to provide the Promoter with personal information such as the participant's name and email address. The Promoter collects participants' personal information in order to conduct the competition and associated research study. QUT's Privacy Policy is available at https://www.qut.edu.au/additional/privacy

Appendix H: Honey and Mumford's Scoring Criteria

The inventory is scored by awarding one point for each item that the participant agrees with. There are no points for items disagreed with. Simply indicate on the lists below which items were ticked by ticking the appropriate question number. The learning style with the highest number is the style most favoured by the participant.

Question on Honey and Mumfords 80 item Questionnaire								
	2		7		1		5	
	4		13		3		9	
	6		15		8		11	
	10		16		12		19	
	17		25		14		21	
	23		28		18		27	
	24		29		20		35	
	32		31		22		37	
	34		33		26		44	
	38		36		30		49	
	40		39		42		50	
	43		41		47		53	
	45		46		51		54	
	48		52		57		56	
	58		55		61		59	
	64		60		63		65	
	71		62		68		69	
	72		66		75		70	
	74		67		77		73	
	79		76		78		80	
Totals								
Learning Style	Activist		Reflector		Theorist		Pragmatist	

Appendix I: Table 6.3 Individual Student Preferences for each Learning Style

Participant	Activist %	Reflector %	Theorist %	Pragmatist %	Dominant Style
1	6.25	**22.5**	17.5	12.5	Reflector
2	22.5	**23.75**	15	15	Reflector
3	8.75	**22.5**	16.25	12.5	Reflector
4	6.25	**20**	16.25	8.75	Reflector
5	8.75	**20**	15	11.25	Reflector
6	2.5	22.5	**23.75**	13.75	Theorist
7	18.75	**20**	17.5	13.75	Reflector
8	12.5	16.25	**17.5**	**17.5**	Multimodal
9	7.5	**20**	11.25	10	Reflector
10	5	**17.5**	**17.5**	13.75	Multimodal
11	3.75	**22.5**	21.25	20	Reflector
12	11.25	**17.5**	15	12.5	Reflector
13	5	**22.5**	16.25	12.5	Reflector
14	6.25	**20**	12.5	2.5	Reflector
15	12.5	**20**	18.75	18.75	Reflector
16	10	18.75	**21.25**	15	Theorist
17	10	**18.75**	11.25	8.75	Reflector
18	20	15	16.25	**21.25**	Pragmatist
19	16.25	16.25	22.5	17.5	Theorist
20	12.5	**22.5**	23.75	16.25	Reflector
21	10	**16.25**	**16.25**	15	Multimodal
22	20	**25**	**25**	22.5	Multimodal
23	13.75	20	**21.25**	17.5	Theorist
24	10	18.75	18.75	**21.25**	Pragmatist
25	11.25	**20**	15	15	Reflector
26	**20**	13.75	12.5	**20**	Multimodal

Participant	Activist %	Reflector %	Theorist %	Pragmatist %	Dominant Style
27	7.5	**15**	13.75	12.5	Reflector
28	12.5	**18.75**	8.75	12.5	Reflector
29	1.25	18.75	**22.5**	18.75	Theorist
30	8.75	**18.75**	10	11.25	Reflector
31	15	**20**	17.5	16.25	Reflector
32	12.5	**17.5**	12.5	6.25	Reflector
33	12.5	11.25	12.5	**20**	Pragmatist
34	13.75	**21.25**	16.25	18.75	Reflector
35	8.75	11.25	11.25	**18.75**	Pragmatist
36	12.5	15	**16.25**	15	Theorist
37	16.25	**18.75**	12.5	18.75	Multimodal
38	7.5	**20**	16.25	10	Reflector
39	7.5	**22.5**	16.25	8.75	Reflector

Appendix J: Table 6.4 Extant Literature Critical Appraisal Results

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP
VI	1. Salvage-Jones, Hamill, Todorovic, Barton & Johnston.	2016	Quazi-Experimental Longitudinal Study	645 undergraduate nursing students across 3 universities in QLD Aus.	While student perception is important for engagement, it doesn't necessarily result in improved overall performance.	Include
VI	2. Clifton & McKillup	2016	Online Survey	Undergraduate nursing students from Qld Aus.	Students may not equate success in bioscience with satisfaction. The attitude, specialisation and teaching expertise of the bioscience educator may influence students perceptions	Include
VI	3. Swift, Efstathiou & Lameu	2016	Structured Survey	129 undergraduate nursing students in the UK.	Innovative teaching methods can work with student nurses' inherent learning preferences, to build the confidence and bioscience knowledge required for clinical practice.	Include
VI	4. Gordon, Hudson, Plenderleith, Fisher, & Craft.	2016	Cross-Sectional Survey	126 Undergraduate nursing students in Aus.	Improved alignment and integration between bioscience and nursing practice subjects may influence nursing student's perception and ability in bioscience units.	Include

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP
VII	5. Redmond, Davies, Cornally, Fegan & O'Toole	2016	Discursive	-	Blended teaching and learning aligns with constructivism theory and may provide a framework through which students are able to integrate theoretical knowledge and practical skills in patient care.	Include
VI	6. Shaffer	2016	Post-Intervention Survey	70 undergraduate nursing students' from the USA.	This study supports the use of a structured teaching approach to improve student perceptions of learning within bioscience.	Include
VII	7. DeLozier & Rhodes	2016	Discursive	-	There are benefits to the use of formative assessment such as in class clickers and in active learning strategies including PBL and group activities.	Include
V	8. Salamonson, Ramjan, van den Nieuwenhuizen, Metcalfe, Chang, & Everett.	2016	Prospective, Correlational Design	563 first year nursing students in NSW Aus.	Nursing students' sense of coherence (comprehension, manageability, and meaningfulness) sociodemographic factors and psychological strengths are related to their academic performance.	Include
VI	9. Hallin.	2016	Quasi-Experimental	174 undergraduate nursing students in Sweden.	In clinical situations nursing students' exhibit low levels of appropriate clinical judgement.	Include

NHMRC	Author/s	Year	Design	Sample/Site	Findings	CASP
IV	10. Vogt & Schaffner	2016	Mixed Methods	46 Post-graduate Nursing students in Ohio, USA.	The use of innovative technological platforms may improve student satisfaction and learning when employed using a synchronous blended learning approach.	Include