Dunk, Vicki (2023) ***Metacognition and self-regulated learning strategy use of Nursing and Allied Health students studying Bioscience.*** **PhD Thesis, James Cook University.**

Metacognition and Self-Regulated Learning Strategy Use of Nursing and Allied Health Students Studying Bioscience.

Vicki Dunk

FHEA

BSc. – James Cook University, Australia

GDip Museum Curatorship – James Cook University, Australia

BTeach (Secondary) – Charles Sturt University, Australia

GDip Science (Neuroscience) – University of New England, Australia

This thesis is submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

at

James Cook University

College of Arts, Society and Education

November 2023

Acknowledgements

I would like to thank my supervisors for the opportunity to undertake this study. My goal was to have a collaboration between Bioscience and Education. Thank you to my advisors Associate Professor Helen Boon and Dr Tanya Doyle from the College of Arts, Society and Education, and Dr Paw Megaw for support within the Biomedicine department. I would also like to thank Dr Judy Craft from University of the Sunshine Coast for sharing her wealth of expertise in teaching nursing students.

My sincere thanks also go to the academics and students who participated in this study.

Finally, I would like to thank my family for their support and encouragement through this journey -- No, I can't promise that this will be the last thing I study!

Statement of the Contribution of Others

Nature of assistance	Contribution	Name
Intellectual support	Editorial assistance	Dr Judy Craft Dr Tanya Doyle Dr Pam Megaw A/Prof Helen Boon
Data Collection	Conduct interviews Interview transcriptions	Dr Ranjna Kapoor Smartdocs Academic Transcription
Statistical support	JCU Stats Help	Dr Daniel Lindsay and Empro Rhondda Jones provided advice on statistical analysis in SSPS and R

Abstract

The aim of this research was to investigate a phenomenon known in the nursing education literature as the 'bioscience problem' and to develop and recommend a learning intervention to assist in addressing the problem. This phenomenon describes nursing students' difficulties with learning, and their corresponding low academic achievement, in the bioscience subjects within nursing programs. This content is critical in providing the foundation for their future clinical practice. Therefore, it is important to investigate solutions that assist students to succeed in this domain. Despite changes in curriculum and teaching methods over the past two decades, this phenomenon continues to be reported in the literature.

Teaching methods associated with self-directed learning theory are commonly employed within nursing and health education, both in higher education programs and in professional development programs. This type of teaching method assumes that adult learners take responsibility for their own learning and progression. However, beginning nursing students tend to report low self-directed learning readiness, suggesting that they may not have the necessary skills and strategies to be successful in self-directed learning environments. Therefore, I proposed that self-regulated learning theory may be a more relevant framework to help students succeed in self-directed learning environments. Self-regulated learning focusses on skills and learning strategies that students can use to improve their academic success, for example, cognitive skills for processing and remembering information, metacognitive skills for monitoring comprehension and progress, and resource management skills such as time management. In addition, self-regulated learning recognises motivational factors that can affect student success such as goal orientation, task value and self-efficacy. Development of declarative, procedural, and conditional knowledge of these learning strategies can lead to improvements in academic achievement and may be important in self-directed learning environments such as those found in many higher education contexts.

In this study, the 'bioscience problem' was investigated within cohorts of first-year undergraduate and diploma students, studying nursing and a range of allied health programs at a regional university. The Motivated Strategies for Learning Questionnaire (MSLQ) was used in a pre- and post -intervention research design to measure differences in student motivations for learning and their use of cognitive, metacognitive and resources management strategies at the beginning and the end of a single semester. For the first-year undergraduate students, no alteration to the current teaching and learning methods occurred across the semester; to allow for an examination of how students learning strategy use may change throughout one study period. For the diploma students, an evidence-based, embedded learning intervention, designed to foster the development of self-

regulated learning skills was developed and delivered to diploma students within a foundation bioscience subject. This method was used to expose all students studying the subject within the diploma to the intervention, rather than relying on students to seek academic support external to the subject. In addition to the MSLQ, diploma students were also invited to semi-structured interviews at the end of the intervention in order to gain further insights into any changes in their learning strategy use as a result of this embedded learning intervention.

The results of the research showed that first-year undergraduate students without prior experience in higher education demonstrated a small decrease in self-efficacy for learning bioscience over their first bioscience subject (without an intervention), while those with prior higher education experience improved their self-efficacy, resulting in a statistically significant difference between groups. All first-year students demonstrated low use of critical thinking skills within the context of biosciences.

Quantitative analysis of the changes in the MSLQ subscales reported by the diploma students were not statistically significant. However, there were important trends in the expected direction in many of the motivation and learning strategy subscales. In particular, students critical thinking skills improved at the end of the semester, with a low-to-moderate effect size (d=0.326). Importantly, there was no decrease in self-efficacy over the semester but there was an increase in the correlation between self-efficacy and academic achievement (Pearson's r= 0.535, p=0.001).

A qualitative aspect of this PhD was undertaken using interviews with student participants who experienced the embedded learning intervention. Overall, interviewees reported engaging with the intervention. In particular, they improved use of key learning strategies, such as peer learning and self-testing. There were also broader themes from the interviews, that reflected students' reports of being introduced to, and using, new-to-them strategies. However, some students reported difficulty implementing some of the strategies independently.

The study intervention showed promising results with overall increases in scores for some of the cognitive learning strategies, particularly critical thinking, as well as increasing exposure to a broad range of unfamiliar learning strategies. Indeed, given the challenges that nursing and allied health students have experienced in relation to the 'bioscience problem', such improvements in learning strategy use are likely to have a positive impact on their learning of bioscience content. Further development and refinement of the intervention should be undertaken, particularly in the development of metacognitive comprehension and self-regulation strategies. In addition, longitudinal investigation of the participants of the intervention are warranted; these may include evaluating these participants for continued use of such strategies as they continue to higher level subjects, as well as consideration of embedding learning strategy intervention over a longer period than was possible in just one semester in the current research.

Finally, although the longitudinal investigation that had been intended was interrupted by COVID-19 lockdowns, the MSLQ, with the addition of an open-ended question was administered to first year undergraduate students studying bioscience. Analysis of this data showed that high achieving students maintained their higher motivation and use of cognitive, metacognitive and resource management strategies throughout the period of uncertainty. On the other hand, and more importantly, low achieving students reported difficulties with effort regulation and had a generally negative view on emergency remote teaching. Lower achieving students' scores on the MSLQ subscales during lockdown were consistent with those in other studies using the questionnaire. Inclusion of the explicit instruction in the use of learning strategies in the first-year subjects may have mitigated the effect of the lockdown by increasing the repertoire of strategies known to lower achieving students prior to the change in delivery. Indeed, specific focus on areas relevant to low-achieving students remains an important area for educators to develop and deliver targeted interventions.

Conferences and presentations

Dunk, V, Craft, J (2023) Self-regulated learning strategy use among nursing and allied health students studying bioscience. 19th National Nurse Education Conference: Create. Innovate. Energise. Gold Coast. June 2023

Dunk, V, Megaw, P, Doyle, T, Boon, H (2021) Effects of self-regulated learning training on foundation bioscience students. In *Proceedings of The Australian Conference on Science and Mathematics Education (ACSME).*

Abbreviations

JCU	James Cook University
MSLQ	Motivated Strategies for Learning Questionnaire
SD	Standard deviation
SDL	Self-directed learning
SRL	Self-regulated learning
SPSS	Statistical Package for the Social Sciences

Table of Contents

List of Tables

List of Figures

1. Chapter 1: Introduction

1.1. Background

Bioscience subjects are an integral part of tertiary nursing and allied health programs. The literature routinely includes the following subject areas under the umbrella term "biosciences": anatomy and physiology, pathophysiology, pharmacology, microbiology, and immunology (Birks et al., 2018; McVicar et al., 2014). Bioscience subjects provide the foundation information about the function of the body in health and disease on which nurses and allied health professionals will base their clinical decision making (Birks et al., 2018; Jensen et al., 2018; McVicar et al., 2014). Basic anatomy and physiology are most often taught in year one of nursing programs (McVicar et al., 2014), while pathophysiology and pharmacology are usually taught in year two (Barton et al., 2021).

For nurses in particular, a thorough understanding of these subjects is important in clinical practice for recognizing and responding appropriately to signs of clinical deterioration (Birks et al., 2018). Furthermore, a number of studies (e.g., Aiken et al., 2014; Davis, 2010; Smales, 2010) show correlations between "sub optimal bioscience knowledge of registered nurses … [and] avoidable morbidity and mortality" (Perkins, 2019, p. 7). Therefore, as noted in the quote below from Shields and Watson (2007) it is vitally important that students are able to remember and integrate information critically to provide the best care.

> *"The consequences of poor education and mistakes are deaths, so the imperative to educate nurses to the highest standard, to provide them with ways to access the best evidence, the critical thinking skills to use that evidence safely and the skills to generate their own knowledge is mandatory" - (Shields & Watson, 2007, p. 71)*

The depth of understanding and application of bioscience knowledge needed by nurses is increasing with longer life expectancy leading to an aging population, and the increasing probability of older people having multiple diseases (Birks et al., 2016; Grady, 2011). In addition, the roles and responsibilities of registered nurses have changed and expanded as the health care system becomes more complex (Birks et al., 2016; Davis, 2010; Kemp et al., 2005; Smales, 2010).

1.2. The 'Bioscience Problem' in Nursing Education

1.2.1. Definition

There is substantial evidence to suggest that nursing and allied health students struggle with the biosciences (Caon & Treagust, 1993; Craft et al., 2013; Haak et al., 2011; Jensen et al., 2018; McVicar et al., 2015). The difficulties experienced by nursing students in the biosciences have come to be referred to as the 'bioscience problem' by some authors (Jensen et al., 2018; McVicar et al.,

2015) and include student perceptions of difficulty as well as student attrition and academic underachievement. A survey of the literature indicates that the problem is ongoing, spanning several decades even though curricula (scope and depth) and teaching methods (for example, from passive learning to active learning) have changed over this time.

1.2.2. Previous Research

Research investigating the 'bioscience problem' tends to focus on the foundation first year bioscience subjects, because poor academic performance in these subjects can lead to attrition from health science programs. To date, research from Australia and internationally about the academic performance of health discipline students in the bioscience disciplines has mainly focussed on nursing students. However, recently there has been an increase in investigations into other allied health students, for example paramedics, pharmacy and rehabilitation sciences students (Colthorpe et al., 2015, 2019a; Maurer et al., 2012; Slominski et al., 2019). One reason for this increase may be that many universities teach first year biosciences (often as an introductory anatomy and physiology subject) as a common subject, catering to students from all the allied health programs available within that university (Page et al., 2017; Rathner & Byrne, 2014; Sturges & Maurer, 2013; Whyte et al., 2011). Another reason may be the increased interest in discipline-based education research (DBER). In the present study it is proposed to include both allied health students and nursing students because the principal bioscience subject being investigated is designed to cater for both groups of students. However, the following discussion will focus on nursing students because this is where much of current research literature is focussed.

Research to address the 'bioscience problem' has been focused in three main areas: **1)** factors that may be predictive of achievement in first year biosciences, such as grade point averages (GPA) (Peterson, 2009) or whether students have completed secondary studies in science (Mckee, 2002; Whyte et al., 2011; Wong & Wong, 1999); **2)** whether teaching strategies such as active learning can improve performance (Bakon et al., 2016; Haak et al., 2011; Johnston et al., 2015; Salvage-Jones et al., 2016; Wilke, 2003) and **3)** student characteristics which may have an impact on success, such as motivation (Maurer et al., 2012; Sturges et al., 2017), engagement (Brown et al., 2017), self-efficacy for learning (Andrew & Vialle, 1998; McVicar et al., 2015) and learning strategy use (Dwarika-Bhagat et al., 2017; Keçeci, 2017; Robb, 2015; Salamonson et al., 2009); along with student perception of, and satisfaction with, bioscience subjects (Whyte et al., 2011). Each of these three areas will now be elaborated.

Factors That May be Predictive of Student Achievement. Factors that have been investigated as potentially predictive of student achievement in introductory bioscience subjects, and nursing programs overall, include previous experience with science, tertiary entrance scores and self-efficacy (Jensen et al., 2018; Wong & Wong, 1999). It has been noted that evidence of predictive power of these factors was inconsistent, and that there were many confounding factors, including those related to student characteristics (McVicar et al., 2015). Overall, this body of research has led to recommendations for higher tertiary entrance scores and prerequisite science subjects for university entrance into nursing and allied health programs (Jensen et al., 2018; McVicar et al., 2015; Ralph et al., 2019; Shulruf et al., 2011; Whyte et al., 2011).

However, most universities in Australia and many in the UK and US (McVicar et al., 2014, 2015; Taylor et al., 2015) are not raising entry requirements to these levels, and some studies indicate that universities are admitting a wider range of students into nursing and allied health programs (as measured by entrance score) due to perceived future workforce shortages in some countries (Beauvais et al., 2014; Maurer et al., 2012; Olsen, 2017). Indeed, a recent Australian report notes that the requirement for pre-requisite science and mathematics has been diminishing and that only 28% of health and medical programs (excluding nursing and midwifery) have senior science entry requirements (Finkel et al., 2020). Therefore, rather than limiting access to subjects and courses, educators need to look for other ways to assist under-prepared students to navigate the cognitive demand of bioscience content. In fact, McVicar et al. (2015) noted that due to the inconsistent reports of benefits of pre-requisite science, there would still be a need to provide support for study skills even if pre-requisites were introduced.

Teaching Strategies. The second area of significance in relation to addressing the 'bioscience problem', namely, the use of teaching strategies (for example, active learning) to improve student achievement, proposes that increasing engagement in learning will lead to greater retention of material. There have been several studies investigating active learning in nursing students, many of which focussed on student perceptions of the subject rather than student performance (Jensen et al., 2018; McVicar et al., 2015). Again, these investigations provided conflicting results. Some studies suggested that nursing students do not like active learning where the onus is on them to have completed some advance preparation, or where their active participation was required (al-Modhefer & Roe, 2010; Freeman et al., 2007); other studies found that nursing students enjoyed active learning (Mikkelsen, 2015). In addition, there have also been mixed results on the benefits of active learning. Montrezor (2016) and Haak et al. (2011) found that active learning improved performance, but Salvage-Jones et al. (2016) found no perceivable impact on assessment outcomes, and in addition, that the small improvement that was detected was not retained over time. Where improvements have been reported, researchers have attributed these to active learning influencing student characteristics. For example, Sungur and Tekkaya (2006) suggest that active learning can increase intrinsic goal orientation.

Student Characteristics. The third key area of consideration in relation to addressing the 'bioscience problem' is that of student characteristics such as motivation, engagement, self-efficacy and learning strategy use.

Self-efficacy is the perception that one is capable of a particular behaviour (Bandura, 2001). Nursing students' self-efficacy for the biosciences has been reported as being relatively low (Andrew et al., 2015; Chen et al., 2019). Self-efficacy is consistently reported as being positively correlated to academic achievement (Honicke & Broadbent, 2016; Zimmerman et al., 1992) and has been suggested as a potential focus of bioscience interventions for nursing students (Andrew et al., 2015).

In addition, nursing and allied health students also tend to be extrinsically motivated (Keçeci, 2017; Maurer et al., 2012; Nilsson & Warren Stomberg, 2008; Salamonson et al., 2009; Sturges et al., 2016). This is thought to be because these students are aiming to get a professional qualification in order to find employment, rather than having an intrinsic interest in the sciences (Cowman, 1998; Snelgrove, 2004) but also due to the more consumeristic nature of education today (Maurer et al., 2013). The importance of this characteristic is that there has been a correlation between extrinsic motivation and surface learning strategies, and, additionally, between surface learning strategies and poor academic performance (Dwarika-Bhagat et al., 2017; Mckee, 2002; Salamonson et al., 2013; Snelgrove, 2004).

Further studies confirmed that nursing students tend to rely more on surface learning strategies, such as memorisation, which leads to an inability to apply concepts in practice (Cowman, 1998; Salamonson et al., 2009; Sand-Jecklin, 2007; Toothaker & Taliaferro, 2017). One reason that students may rely on surface learning strategies in the biosciences is because they are content heavy subjects i.e., they contain a large amount of factual information (Craft et al., 2013; Gordon et al., 2017). When learning a complex body of knowledge, the initial phase often requires a degree of memorisation (Hattie & Donoghue, 2016; Shuell, 1990), however, nursing students are not moving beyond this phase. Snelgrove (2004) suggests that in trying to accommodate students of varying abilities, some nursing departments are inadvertently encouraging surface learning by examining at too basic a level. This is a sentiment that is echoed more generally in bioscience education due to the content-heavy nature of foundation subjects (Momsen et al., 2010).

In addition to the use of surface learning strategies, Andrew and Vialle (1998) suggest that low achieving students don't know how to study for science, i.e. they do not know how to use deep learning strategies or which cognitive strategies would be useful, and suggest that we need to make the approaches for learning in the sciences familiar to them. Encouraging students towards deep learning should be an aim of teaching strategies (Dwarika-Bhagat et al., 2017; Mckee, 2002). It has been suggested that it is time to consider interventions that more fully prepare students for the biosciences (McVicar et al., 2014, 2015; Salvage-Jones et al., 2016). For these reasons this research focuses on the area of student characteristics, particularly metacognition and self-regulated learning strategy use.

1.3. Study Aims and Objectives

The aim of this research project was to design and implement an integrated self-regulated learning intervention, that was seamlessly embedded within a foundation bioscience subject. The intervention was designed to increase students' self-efficacy for bioscience and their use of cognitive, metacognitive and resource management strategies in pursuit of their academic goals, to improve their achievement within the bioscience subjects in their professional programs. The Motivated Strategies for Learning Questionnaire (MSLQ) was used to measure students' motivations and use of cognitive, metacognitive and resource management learning strategies within bioscience subjects that were studied at diploma and first-year undergraduate level. Therefore, the following objectives were defined:

1. investigate the relationship between science self-efficacy, motivation, and self-regulated learning strategy use, as measured by the MSLQ, and achievement in baccalaureate students in health sciences;
2. design a self-regulated learning educational intervention that is embedded within the bioscience curriculum;
3. investigate the relationship between science self-efficacy, motivation, and self-regulated learning strategy use, as measured by the MSLQ, and achievement in diploma students in health sciences;
4. investigate whether explicit instruction in cognitive and metacognitive strategies influence self-efficacy, motivation, and self-regulated learning strategy use, as measured by the MSLQ, in diploma students in health sciences.

COVID lockdown affected the final data collection, therefore, the effects of emergency remote teaching had to be considered.

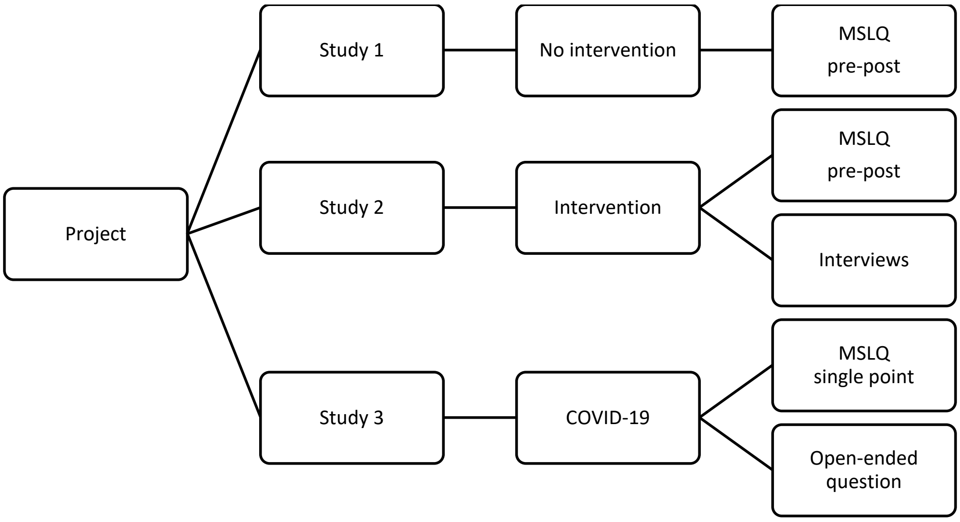

Figure 1-1 Schematic of the sequence of data collection across the three studies included in this research project.

1.4. Experimental Design

A convergent parallel mixed-method experimental design was used to investigate the efficacy of the intervention. Quantitative data was collected at the beginning and end of the intervention using the MSLQ, while qualitative data was collected at the end of the intervention using semi-structured interviews of the intervention participants.

1.5. Sequence of Study

The concept of adult education, and in particular, self-directed learning as defined by Knowles (1975) has been widely embraced by the nursing education community (Nolan & Nolan, 1997a). This method of instruction has been criticised (Darbyshire, 1993; Nolan & Nolan, 1997a; Townsend, 1990) as not appropriate for all nursing students, on the basis of the premise that all adults want to take responsibility for their own learning. While reviewing the literature related to nursing students' use of study time, Barker et al. (2016) found many articles suggesting that nursing students are not ready for self-directed learning. One of the key competencies recommended by Knowles (1975, p. 60) for successful self-directed learning was "the ability to select effective strategies for making use of learning resources and to perform these strategies skilfully and with initiative". On the one hand, this is rarely mentioned in the nursing self-directed learning literature, and on the other hand, there are often suggestions that the study skills of nursing students need to be enhanced. Self-regulated learning is an alternative framework, based on investigations aiming to understand the processes and skills used by high achieving students to reach their learning goals (Zimmerman & Martinez-Pons, 1986). Therefore, Chapter 2 presents a discussion of the similarities and differences between these two frameworks with the proposal for the application of self-regulated learning in the foundation bioscience subjects.

A review of the literature pertaining to self-regulated learning amongst nursing and allied health students within the biosciences is presented in Chapter 3. There is a scarcity of publications investigating any changes in the use of learning strategies by nursing and allied health students from the beginning to the end of their first semester first year undergraduate bioscience subjects. Therefore, the next phase of the current investigation conducted a pre-semester and post-semester investigation of students using the Motivated Strategies for Learning Questionnaire (MSLQ) as a measurement instrument, which is reported in Chapter 4.

The embedded learning intervention was developed in 2019 using the cyclical model of Zimmerman (Zimmerman & Moylan, 2009) adjusted in accordance with the conceptual framework of Pintrich (2000, 2004). The intervention involved the explicit instruction of a learning cycle featuring planning, performing, and evaluating phases and including cognitive, metacognitive and resource management strategies and skills. Development of the intervention program, content and sequencing are detailed in Chapter 5.

The intervention was subsequently implemented within a diploma bioscience subject. The MSLQ was used as a measurement instrument to compare pre-semester and post-semester responses, and the results of this investigation are presented in Chapter 6. In addition, intervention participants were invited for semi-structured interviews at completion of the subject. The interviews were thematically analysed to gain insights into students' experiences with the intervention and the learning of foundation bioscience, which are reported in Chapter 7.

At the commencement of the recent COVID-19 pandemic, the world entered lockdown and the proposed project required a slight redesign. The MSLQ was conducted during the first weeks of lockdown for students in first semester first year bioscience subjects. Due to the lockdown, there were two unique questions focussed on student perceptions of their study strategies during this time. The results of this mixed method investigation are presented in Chapter 8.

1.6. Thesis Outline

Most chapters in this thesis have been written in a format to facilitate publication in peer review journals.

Chapter 1 introduces the 'bioscience problem' within the nursing education context and discusses the various approaches that have been taken in the literature to address this problem.

Chapter 2 discusses the rationale for the use of the theoretical framework of self-regulated learning and compares this with the similar self-directed learning framework that is often used in nursing education. I conducted the analysis and wrote the chapter, and my supervisors critically reviewed and edited the manuscript.

Chapter 3 presents a review of the literature pertaining to studies of self-regulated learning within nursing and allied health student populations prior to the development of this intervention. I conducted the literature search and selected the articles for inclusion. I also wrote the review, and my supervisors critically reviewed and edited the manuscript.

Chapter 4 reports on the measurement of the motivations and self-regulated learning strategy use of first year, first semester undergraduate nursing students studying bioscience, at the beginning and end of the semester, using the Motivated Strategies for Learning Questionnaire (MSLQ). I designed the study, collected the data, conducted the analysis, and wrote the chapter, and my supervisors critically reviewed and edited the manuscript.

Chapter 5 describes the design of a learning intervention to coach students to use self-regulated learning strategies within the biosciences, by embedding explicit instruction within a foundation bioscience subject. I designed the learning intervention and wrote the chapter, and my supervisors critically reviewed and edited the manuscript.

Chapter 6 reports on using the MSLQ as a measurement tool at the beginning and end of a one-semester foundation bioscience subject with embedded self-regulated learning skill training. I designed the study, conducted the intervention, collected, and analysed the data and wrote the chapter, and my supervisors critically reviewed and edited the manuscript.

Chapter 7 reports on student insights into their participation in the foundation bioscience subject with embedded self-regulated learning skill training. A person unconnected to the students conducted the interviews. I designed the study, conducted the analysis of the interview data, and wrote the chapter, and my supervisors critically reviewed and edited the manuscript.

Chapter 8 reports on student motivation and self-regulated learning strategy use at the beginning of lockdown during the COVID-19 pandemic in 2020. I designed the study, collected the data, conducted the analysis, and wrote the chapter, and my supervisors critically reviewed and edited the manuscript.

Chapter 9 provides a summary of the previous chapters and provides an overall discussion of the learning intervention and the MSLQ as a method of data collection. This is followed by the conclusion and recommendations for future research. I wrote the chapter, and my supervisors critically reviewed and edited the manuscript.

2. Chapter 2: A critique of self-directed learning in comparison to self-regulated learning within nursing education.

2.1. Abstract

This chapter provides a discussion of two similar learning frameworks that are often confused, or used synonymously, within the education literature. The first is self-directed learning, which has been widely implemented within nursing, allied health, and medical education. A review of the interpretation, and use of, self-directed learning within nursing education is given, along with discussion about nursing student readiness for this type of learning. Following that, an alternative framework, self-regulated learning, is discussed. After reviewing both learning frameworks, the use of self-regulated learning theory to support the development of motivations and skills in the use of learning strategies by nursing students to enhance their self-directed learning is recommended.

2.2. Background

Self-directed learning (SDL) is a widely implemented instructional method in nursing education both in the formal tertiary setting and within ongoing professional development once working as a registered nurse. Within the tertiary setting, self-directed learning as an instructional method makes several assumptions about the skills, experiences, and attitudes of students at entry to their programs that may be unfounded. In addition, there have been many recommendations that the skills of self-directed learning should be explicitly taught to students in their early years of university study (Barker et al., 2016; Nilsson & Warren Stomberg, 2008; Nolan & Nolan, 1997a; Smedley, 2007; Timmins, 2008). According to the literature, these recommendations are often met with concern due to curriculum time constraints or educators struggle with the concept (Nolan & Nolan, 1997a; Timmins, 2008).

There is a similar framework, self-regulated learning (SRL), which may offer some direction in implementing upskilling of students to prepare them for self-directed learning. There has been some confusion between these two concepts (SDL and SRL), both within the health professional education literature, and the education literature more widely. This is due, in part, to the very similar definitions. There are, however, differences in the theoretical underpinnings and implementation of the two. Some of the differences have been discussed in reviews (Husmann et al., 2018; Loyens et al., 2008; Saks & Leijen, 2014), with the consensus being that self-directed learning is the more over-arching concept, and self-regulated learning is more focussed on the skills used by the learner to reach their learning goals. The distinction between SDL and SRL is best summed up by Saks and Leijen (2014, p. 192); “a self-directed learner is supposed to self-regulate, but a self-regulated learner may not self-direct”. This would suggest that if a learner does not have self-regulated learning skills, they will not be able to self-direct.

Therefore, the following paper will give a summary of the two frameworks and discuss the ways in which training to develop self-regulated learning skills may enhance students' ability to benefit from instruction using self-directed learning.

2.3. Self-Directed Learning

"Self-directed learning may well be the most prominent and well researched topic in the field of adult education" (Garrison, 1997, p. 18). Self-directed learning has been conceptualised in several ways. It has been thought of as a method of instruction, as a goal of instruction and as attributes of an adult learner (Merriam & Baumgartner, 2020). The term comes from the work of Knowles (1975, p. 18) where it is described as a method of "helping adults learn". Knowles' definition of self-directed learning is widely cited in the nursing education literature:

> *self-directed learning describes* ***a process*** *in which individuals* ***take the initiative****, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies and evaluating outcomes (p.18) (my emphasis)*

Knowles' work is partly based on that of Tough (1967) who, in the work entitled "Learning without a teacher", sought to understand the processes used by motivated adults to learn knowledge or skills **that they want** as they move through life. Tough termed this "self-teaching" because it was primarily undertaken outside of formal educational institutions. Knowles (1975, p. 18) states that the new definition of self-directed learning provided subsumes this term and a range of other terms common in the literature including, self-planned learning, inquiry method, independent learning, self-education, self-instruction, self-study and autonomous learning. Knowles also notes, that while these terms all suggest that the learning occurs alone, it actually involves a collaborative construction of meaning.

Knowles (1975, p. 19) makes a distinction between self-directed learning, which is then further termed andragogy, and pedagogy. Knowles notes that pedagogy is 'the art and science of teaching children' and is more teacher directed, while andragogy is 'the art and science of helping adults learn'. There has been some criticism in the literature of the assumption that all adults are more motivated than all children (Darbyshire, 1993). However, Knowles contends that a certain level of maturity is required, at least in terms of prior experiences, for andragogy to be the correct choice of instructional method (Knowles, 1975, p.19, p.21, p. 60). Finally, one of Knowles' four major tenets of andragogy is that "adults have a deep psychological need to be generally self-directing" (1980, p. 43), which seems to be a major driver for use of self-directed learning as an instructional method.

However, Long (1990) argues that the actual teaching and learning processes of self-directed learning, or andragogy, are the same as for traditional learning, or pedagogy. These are: diagnosing learning needs, setting objectives, identifying resources and evaluating learning. Long contends that the real difference between the two is not the process, but the active psychological control of the learning process by the learner. Long draws on the work of Kasworm (1988, p. 69) who notes that a self-directed learner 'has consciously accepted the responsibility to make decisions, to be one's own learning change agent, rather than abrogating the responsibility to external sources or authorities.'

2.3.1. Self-Directed Learning in Nurse Education

Self-directed learning as a method of instruction is commonly used within nursing, medicine, and other health education programs. Its introduction into nursing education programs stemmed from a push by accreditation bodies (such as the English National Board for Nursing, Midwifery and Health Visiting (ENB) and the United Kingdom Central Council for Nursing, Midwifery and Health Visiting (UKCC)) to produce graduates who were life-long learners, with skills to self-direct their professional development learning (Nolan & Nolan, 1997a; Timmins, 2008; Wiley, 1983). There was a prevailing opinion that previous teacher-centred methods of teaching nurses (suggested to rely on rote learning of facts) had left registered nurses under-prepared for continued learning in the rapidly changing healthcare setting (Hurst, 1985). It was believed that by requiring students to take responsibility for their own learning during their undergraduate degree, they would develop the skills to self-direct their learning as technology and practices of health care changed. This developmental goal is based on the assumption that it is possible to increase an individual's ability to self-direct their learning by employing a self-directed learning framework that would require the students to self-direct (Fisher et al., 2001).

Nolan and Nolan (1997a) credit the uptake of self-directed learning as an instructional method in nursing education (in the UK, at least) to Jones (1981). In that paper, Jones gives a review of some early research and provides an example of implementation in a nursing module to assist other nurse educators in developing their own instructional modules. Following that paper "most educators publishing in the 1980s turned to adult and student student-centred approaches as a solution to the problems of the existing system" (Nolan & Nolan, 1997a, p. 52). Since that time, self-directed learning as an instructional method has been implemented in a variety of different ways; examples include learning contracts, problem-based learning, timetabling independent study time, clinical learning logs, distance programmes and more recently blended mode and flexible delivery (Barker et al., 2016; Kocaman et al., 2009; Smedley, 2007).

Thus, nursing education employed self-directed learning as an instructional method for two main reasons 1) with a goal to develop students who could be self-directed, so that after graduating they could engage with on-going professional development; and 2) because adult education literature assumed that adult students naturally learn this way, and that they would prefer it. However, some authors criticised the widespread adoption of self-directed learning as a teaching method because the assumptions about the way adults learn were not empirically tested (Darbyshire, 1993; Nolan & Nolan, 1997a; Timmins, 2008). In particular, there were questions regarding the assumptions that all adults are *motivated* and *able* to undertake learning on their own, and that adult learners prefer *autonomy* over their learning. In addition, it has been suggested that learning for professional programs is different from general adult education because the "learning outcomes are pre-set and specific to ensure that nurses are fit for purpose" (Walsh, 2004, as cited in Timmins, 2008, p. 303).

Furthermore, implementation of self-directed learning as an instructional method was not without problems. Nolan and Nolan (1997a) highlight a number of reports of student dissatisfaction, frustration and anxiety. For example Townsend (1990, p. 67) found that beginning "students did not want to know about autonomy, freedom, process and change. They wanted direction, order, and content". In addition, Slevin and Lavery (1991) and Dyck (1986) provide some anecdotal evidence that students felt that instructors were not doing their jobs by using self-directed learning methods. In a review of the literature relating to student perceptions of various teaching methods, McCarthy (1995, p. 53) concluded that while nursing students have a positive attitude to most teaching methods, "many nurses and nursing students prefer direct, concrete, teacher-structured experiences" and "prefer highly organised activities with clearly stated requirements and expectations".

Investigations comparing beginning students in nursing with those in social work and teaching found that nursing students have a stronger preference for teacher-direction and are less willing to participate in self-direction of learning (Boström & Hallin, 2012; Turunen et al., 1997). Furthermore, Wiley (1983) reported that nursing students who preferred high structure actually decreased in self-directed learning readiness during an SDL-project, leading Wiley to suggest that this method of instruction may not increase self-directedness in all students (Wiley, 1983).

A review of self-directed learning in nurse education found there to be inconsistencies in implementation, that were partly caused by vague definitions (O'Shea, 2003). In general, definitions of self-directed learning within the nursing education literature "describe a process of learning based on the principles of adult education" that contain "the notion of some personal control by the learner over the planning and management of learning" (O'Shea, 2003, p. 63). O'Shea concluded that "the lack of a common understanding means that implementation of self-directed learning is inconsistent and leads to anxiety for students" (O'Shea, 2003, p. 69). However, they did conclude that a *student-centred approach* (rather than an entirely self-directed approach) to teaching may facilitate an increase in self-directed learning abilities.

2.3.2. Measuring Self-Directed Learning Readiness

Several authors have recommended measuring the self-directed learning readiness of students before using this method of instruction (Iwasiw, 1987; Slevin & Lavery, 1991; Torrance & Mourad, 1978). Knowles (1975, p. 61) included a table with eight competencies that a student should possess in order to get full benefit from a self-directed learning process, with space for an additional two competencies to be added by the educator, as required. The competencies are shown in Table 2-1.

Table 2-1 Competencies of Self-Directed Learning: Self-Rating Instrument.

Competency	none	weak	fair	strong
1. An understanding of the differences in assumptions about learners and the skills required for learning under teacher-directed learning and self-directed learning, and the ability to explain these differences to others				
2. A concept of myself as being a non-dependent and self-directing person				
3.The ability to relate to peers collaboratively, to see them as resources for diagnosing needs, planning my learning and learning; and to give help to them and receive help from them				
4. The ability to diagnose my own learning needs realistically, with help from teachers and peers				
5. The ability to relate to teachers as facilitators, helpers, or consultants, and to take the initiative in making use of their resources				
6. The ability to identify human and material resources appropriate to different kinds of learning objectives				
7. The ability to select effective strategies for making use of learning resources and to perform these strategies skillfully and with initiative				
8. The ability to collect and validate evidence of the accomplishment of various kinds of learning objective				
9. [Additional competency to be added by the educator]				
10. [Additional competency to be added by the educator]				

Note. My emphasis. Adapted from "Self-directed learning: A guide for learners and teachers" by M.S Knowles, 1975, Cambridge Adult Education Prentice Hall Regents. (p. 61) © 1975 Malcolm S. Knowles

A more comprehensive self-report instrument was developed by Guglielmino (1977) based on Knowles theory, and this instrument has been widely used both in nursing education (Barker et al., 2016; Cadorin et al., 2017; Slater et al., 2017) and other higher education subject domains. In the literature it can be known as the Self-Directed Learning Readiness Scale (SDLRS) or the Learning Preference Assessment (LPA). The questionnaire is copyrighted and must be purchased (www.lpasdlrs.com).

Guglielmino's (1977, p. 73) defines a self-directed student as follows:

> *[A] highly self-directed student is one who exhibits initiative, independence, and persistence in learning; one who* ***accepts responsibility*** *for his or her own learning and views problems as challenges, not obstacles; one who is capable of self-discipline and has a high degree of curiosity; one who has a strong desire to learn or change and is self-confident; one who is* ***able to use basic study skills****, organise his or her time and set an appropriate pace of learning, and to develop a plan for completing work; one who enjoys learning and has a tendency to be goal oriented (my emphasis)*

The adult version of the instrument contains 58 items rated on a 5-point Likert-type scale, which Guglielmino (1977, in Demirel & Coşkun, 2010) suggested covered eight dimensions, as follows:

1. Openness to learning opportunities
2. Self-concept as an effective, independent learner
3. Initiative and independence in learning
4. Informed acceptance of responsibility for one's own learning
5. Love of learning
6. Creativity
7. Positive orientation to the future
8. **Ability to use basic study skills and problem-solving skills** (my emphasis)

A visual summary of this information is provided in Figure 2-1, which shows the emphasis on characteristics and attitude of the learner.

Figure 2-1: The Self-Directed Learner

Note. The attitudes, abilities and personality characteristics of Guglielmino's model as interpreted by Taylor (1995, p. 3). Taylor groups Guglielmino's descriptions of the dimensions into attitudes, characteristics, and skills of the learner. This clearly shows the stronger focus on the attitudes and characteristics of students. Adapted from "Self-directed learning: Revisiting an idea most appropriate for middle school students" by B. Taylor, 1995, Paper presented at the Combined Meeting of the Great Lakes and Southeast International Reading Association. Nashville, TN.

Responding to the criticism about the validity of the 8-factor structure (Field, 1989, 1990; Straka & Hinz, 1996) and the cost, Fisher et. al., (2001) developed a nursing specific measurement instrument called the Self-Directed Learning Readiness Scale for Nursing Education (SDLRSNE). In positioning their instrument within the self-directed learning literature, Fisher et. al., (2001, p. 517) use Wiley's (1983, p. 182) abbreviated version of Guglielmino's definition of readiness: "the degree the individual possesses the **attitudes**, **abilities** and **personality** characteristics necessary for self-directed learning" (see also Figure 2-1) The SDLRSNE has 40 items across three dimensions: self-management, desire for learning, and self-control, thus this instrument, similar to the original, focusses on traits of the student.

In total, four different measurement instruments have been used to measure self-directed learning readiness in nursing education, all of which state specifically that they are based on Knowles theory of self-directed learning (Cadorin et al., 2017). In addition to the two instruments discussed above, there are two other instruments used in published studies: the Self-Rating Scale of Self-Directed Learning (SRSSDL) (Williamson, 2007) and the Self-Directed Learning Instrument (SDLI) (Cheng et al., 2010). The number of items on each of those scales were lower, as were the number of dimensions. Cadorin et al., (2017) note that some of the dimensions and items are similar across the four instruments, although different terminology is used. Furthermore, they point out that the final two instruments focus less on the traits of the students, and more on their self-reported skills or abilities. However, the majority of readiness studies within health-related disciplines, and nursing in particular, use either the SDLRS (57%) or the SDLRSNE (45%) (Slater & Cusick, 2017).

Both the SDLRS and the SDLRSNE focus on attributes of the student (Cadorin et al., 2017), and there has been some debate in the literature about whether attributes are amenable to change or development or whether these are relatively stable, personality-like, traits (Slater & Cusick, 2017). If this was the case, it would mean that the goal of developing self-directedness, as measured by these instruments, may be difficult to achieve.

Furthermore, another drawback of these readiness instruments is that they are usually deployed at a global level, meaning that students are asked to rate the items generally, rather than in a context-specific way. As such, students would likely be considering the items in terms of program-level learning, applying the statements across all of the subjects they were undertaking. At any one time students could be studying bioscience, ethics and law, health administration and clinical skills, each of which will have distinct learning environments and expectations (Sutcliffe, 1993).

Knowles early work (1975) asserted that there are learning situations which may be less suited to self-directed learning and more suited to teacher-direction. This included situations where:

- the student has little or no previous experience with the subject (e.g., biosciences, clinical skills)
- the focus is on learning the content (e.g., content-heavy subjects - bioscience)
- the student is motivated by external pressures (e.g., accreditation) (Knowles, 1975, p. 21)

This suggests that Knowles recognised that there is a degree of context-specificity to a student's self-directedness. Nolan and Nolan (1997b, p. 105) note that "these [exceptions] apply to a greater or less extent in nursing education". Several other adult education theorists have expanded on the concept of context-specificity and note that there may be times where a competent self-directed learner becomes "temporarily dependent", particularly when learning something new (Candy, 1991; Grow, 1991; Pratt, 1988). Four variables have been identified in the literature that influence autonomous learning behaviour. These variables are as follows, with a link to self-regulated learning theory in parenthesis: 1) technical skills related to the learning process (use of learning strategies), 2) familiarity with the content (prior knowledge), 3) sense of personal competence as learners (self-efficacy and control of learning beliefs) and 4) commitment to learning at this point in time (motivation) (Merriam & Baumgartner, 2020, p. 158).

Self-directed learning readiness of nursing students has been widely studied (Barker et al., 2016; Cadorin et al., 2017; Slater & Cusick, 2017; Wong et al., 2021), with little consensus about factors influencing readiness. Slater and Cusick (2017) identified a total of 21 potential factors, including demographic factors, educational background, program factors (e.g., year level or delivery type), academic factors (e.g., learning styles, achievement) and professional factors. Although there are inconsistencies in the results longitudinally and cross-sectionally, the authors concluded that evidence is emerging to suggest that age, year level and previous level of education could be correlated with readiness. Further, they postulate that this emerging pattern is pointing to the accumulation of experience as the key to improving readiness. However, there is still no clear pattern about the types of experiences that have the greatest effect on improving readiness. The authors also suggest it could be due to a "more encompassing [developmental and social] constructs" (Slater & Cusick, 2017, p. 31), which is something that cannot be taught.

2.3.3. Other Models of Self-Directed Learning

While the nursing education literature identifies Knowles' (1975) model as the primary model informing the process of self-directed learning, two other models are included in this review. These two models are Grow's (1991) Staged Self-Directed Learning Model and Garrison's (1997) Comprehensive Self-Directed Learning Model. These models provide more contemporary views of self-directed learning.

Grow's Staged Self-Directed Learning Model. Grow's (1991) model is occasionally mentioned in the nursing education literature (Kaulback, 2020). This model is based on the situational leadership model of Hersey and Blanchard (1988, in Grow, 1991). It is designed to assist educators in matching teaching style with self-directed readiness to promote the development of the learner, making it an instructional model (Merriam & Baumgartner, 2020). Grow (1991) asserts that learners progress through stages of increasing self-directedness. These are:

1) Stage 1: Dependent learner, low self-direction, high teacher dependence
2) Stage 2: Interested learner, moderate self-direction, interested in the content, but new to it
3) Stage 3: Involved learner, intermediate self-direction, has both skills and basic knowledge,
4) Stage 4: Self-directed learner, high self-direction, "willing" and "able" to plan, execute and evaluate their learning.

For each of these stages, Grow provides examples of the types of teaching and learning activities that may benefit the learner. Grow advocates matching the learner to the activities as much as possible and discusses the implications of the range of mismatches that can occur.

Garrison's Comprehensive Self-Directed Learning Model. Garrison's model has not been widely cited in the nursing education literature. This model comes much closer to the models of self-regulated learning which will be discussed in the next section. Garrison (1997, p. 20) argues that the literature regarding self-directed learning had been too focused on aspects of **self-direction** (the "need to learn on one's own") and not focused enough on aspects of **learning**. Thus, his model attempts to shift the focus away from self-management exclusively by including cognitive/metacognitive and motivational dimensions of learning. Garrison draws heavily on the self-regulation literature.

Garrison's (1997, p. 21) model has "three overlapping dimensions": self-management, self-monitoring, and motivation. In his description of *self-management*, Garrison explicitly references self-regulated learning theory "the essence of the concept can be found in the self-regulated motivational literature (Corno, 1994; Pintrich & DeGroot, 1990)" (Garrison, 1997, p. 23). His conceptualisation of self-management includes resource management and "what learners *do* during the learning process" (original emphasis).

Garrison's *self-monitoring* dimension encompasses cognitive and metacognitive processes. Garrison considers cognitive ability to be central to self-directed learning: "Learners will not succeed and persist in their learning without cognitive abilities and available strategies. The degree of self-direction will depend very much upon the learner's proficiency (abilities and strategies) in conjunction with contextual and epistemological demands" (Garrison, 1997, p. 25). Here Garrison draws on a number of prominent self-regulated learning authors, beginning with Bandura's social cognitive theory of self-regulation, which is the basis of self-regulated learning theory, and extending to Zimmerman's (1989) fourteen self-regulated learning strategies and other cognitive skills and strategies examined by Winne (1995), for example task analysis and information processing.

A key point of this model is that students must have proficiency. This notion that students must have skills to be able to select and use a range of strategies or 'study skills' is included in most of the definitions of self-directed learning in this review, including Knowles (1975), but it seems not to have had a place of importance in the literature. In order for a student to have the "freedom to" do something, they "must have the *ability* to perform the act he or she is free to perform" (Rich, 1989 in Long, 1990, p. 335).

Therefore, it would be beneficial to look at other frameworks for methods to increase students' use of learning strategies. Learning strategies include a range of behaviours that a student can use to increase the probability of reaching their learning goals by influencing the encoding process (Weinstein & Mayer, 1983). The strategies aim to create meaningful memories that can be retrieved at a later time for critical thinking and problem solving, such as in the clinical setting. Many authors have suggested that the ability to self-regulate the use of cognitive, metacognitive and resource management learning strategies helps students to gradually accept responsibility of their own learning and to become lifelong learners (Dignath & Büttner, 2008; Iyama & Maeda, 2018; Paris & Paris, 2001; Schunk, 2005).

2.4. Self-Regulated Learning

In contrast to self-directed learning, self-regulated learning has its origins in educational psychology, based on social cognitive theory and in relation to learning tasks within the traditional classroom, which may be a reason it is not embraced in adult education. Greene (2017, p. 6) notes that self-regulated learning research is "an intentional integration of social cognitive theory with learning strategy, metacognition, and motivation research" in an attempt to understand *how* students can achieve their learning goals, namely, what actions do they take and what skills do they use, rather than focusing on who has responsibility for setting the overall goals.

The definition of self-regulated learning from Pintrich (2000, p. 453) is widely used and states that:

> *A general working definition of SRL is that it is an active, constructive* ***process*** *whereby learners set goals for their learning and then attempt to monitor, regulate, and control, their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features of the environment.*

2.4.1. Social Cognitive Theory

The basis of self-regulated learning theory is social cognitive theory, which was developed by Bandura (1986). Social cognitive theory was a departure from behaviourist theories and centred on individual agency (Bandura, 1986, 1991). Having agency means that individuals are both active contributors to, and also products of, their life circumstances. Bandura argued that agency occurs through a triadic reciprocity (also called reciprocal determinism) (see Figure 2-2) between personal factors, behavioral factors and environmental factors. Personal factors can be cognitive, affective or biological events, while environmental factors can be imposed, selected or construed. Each factor can affect the others and be affected by them. Bandura (2012) explains that agency has four core principles: intentionality, forethought, self-reactiveness and self-reflectiveness which lead to the self-regulation of behaviour. Intentionality and forethought give rise to goal directed behaviours, because individuals are able to set goals and anticipate likely outcomes (Bandura, 2012). Self-reactiveness and self-reflectiveness (which includes self-observation and self-evaluation) are the ways in which the individual monitors their actions and makes adjustments (Bandura, 1986, 2012). These principles form a feedback loop for adjusting behaviours to achieve goals. This feedback loop is the basis for Zimmerman's cyclical phase model of self-regulated learning (Figure 2-3).

Content has been removed
due to copyright restrictions

Figure 2-2: Triadic Reciprocity.

Note. Students have agency, which influences, and is influenced by personal factors and environmental factors. Adapted from "Social foundations of thought and action: A social cognitive theory" by A. Bandura, 1986, Prentice-Hall, Inc.

2.4.2. Models of Self-Regulated Learning

Several models of self-regulated learning have been developed based on social cognitive theory. The models share many commonalities, the main difference between them is which component is most emphasized (Panadero, 2017). All of the commonly used models conceive self-regulated learning to be a cyclical or iterative process, generally beginning with a preparatory or planning phase, followed by performance and evaluative phases (Panadero, 2017; Pintrich et al., 2000; Zimmerman, 2000). These phases occur in a loosely time ordered manner but are recursive, feedback from the performance and evaluative phases may cause changes to the goals as performance is occurring (Pintrich, 2004). This chapter will focus on the two most widely cited models: Zimmerman's cyclical phase model (Zimmerman & Moylan, 2009) and Pintrich's (Pintrich,

2004) conceptual framework. For a comprehensive review of other models of self-regulated learning see Panadero (2017).

Zimmerman's Cyclical Phase Model of Self-Regulatory Feedback. Using social cognitive theory, Zimmerman developed and refined a model to encapsulate the agentic feedback loop used by high achieving students to achieve their learning goals (Zimmerman, 1989, 2000a; Zimmerman & Moylan, 2009). The most recent version of the model is shown in Figure 2-3.

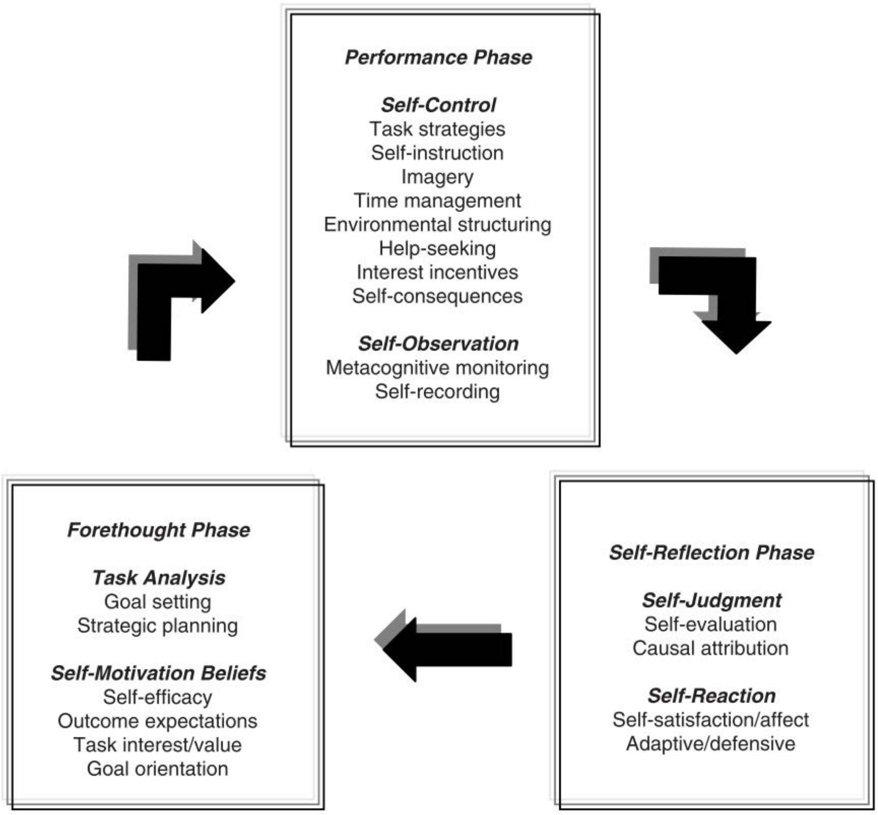

Figure 2-3: Zimmerman's Cyclical Phase Model of Self-Regulation

Note. Within each phase a variety of strategies are used. From "Self-regulation: Where metacognition and motivation intersect" by B.J. Zimmerman and A. Moylan, 2009, *Handbook of Metacognition in Education.* P. 300. (http://doi.org/10.4324/9780203876428.ch16) . Used with permission. © Taylor and Francis Group.

The cyclical feedback loop is occurring at the level of the learning task. In the cyclical model, the preparatory or planning phase is called the forethought phase. According to Bandura (2012) forethought makes people proactive, not just reactive. During the forethought phase, students deconstruct the task, set goals and plan their strategies (Zimmerman, 2000a, 2002; Zimmerman & Moylan, 2009). In this context, goals are relatively short term: what students are aiming to achieve in a study session or with an individual assignment. The goals provide a standard against which the students can self-evaluate at the conclusion of the task (Zimmerman & Moylan, 2009). Students require a repertoire of learning strategies from which to choose, they need to have knowledge that a strategy exists (declarative knowledge) and how to perform the strategy (procedural knowledge), and in which circumstances and contexts it is likely to be most effective (conditional knowledge) (Schraw et al., 2006). Factors such as self-efficacy, outcome expectations, interest and goal orientation affect this phase.

The second phase in the cycle is performance and is made up of two tasks: self-control and self-observation. During this phase the student is completing the task using the strategies they identified in the forethought phase. At the same time, they are monitoring their progress towards the goal, and adjusting their behaviour as required. The list of strategies given under the self-control heading in Figure 2-3 is illustrative of a range of cognitive/information processing, metacognitive and motivational strategies that have shown good correlation with achievement in learning research (Zimmerman & Moylan, 2009).

The final phase in this model is self-reflection, where students evaluate their performance. It is made up of self-judgement, where students evaluate their performance against a standard and attribute causal significance (e.g., luck, effort); and self-reaction, where students determine if they are satisfied with the results and respond either adaptively or defensively (Dibenedetto & Zimmerman, 2013; Zimmerman, 2000a).

Zimmerman's model emphasizes the cyclical process of self-regulation. However, it also describes factors which may influence student's behaviour, and strategies that student's use during each of the phases. The strategies included in this model cover cognitive and information processing strategies, resource management strategies, and metacognitive and motivational strategies.

Pintrich's Conceptual Framework. Pintrich (2000, p. 452) undertook an integrative review of the different models of self-regulated learning available and proposed a "synthetic overview and general framework for theory and research in self-regulated learning". Pintrich noted that there are four general assumptions that are common to models of self-regulated learning: 1) learners are active participants in the learning process; 2) learners have the *ability* to monitor, control and regulate aspects of their cognition, motivation and behaviour and some features of their environments; 3) there is a goal or standard, which allows the learner to determine whether modifications to the learning process need to be made; and 4) "self-regulatory activities are mediators between personal and contextual characteristics and actual achievement or performance" (Pintrich, 2000, p. 453). His framework attempts to integrate these assumptions, along with the main constructs of the various models. The framework consists of four phases:

forethought, planning and activation; monitoring; control; and reaction and reflection, and Pintrich also notes that regulation occurs across four different areas: cognition, motivation and affect, behaviour, and context. In 2004, Pintrich presented the model again in relation to measuring self-regulated learning strategy use and included links to his Motivated Strategies for Learning Questionnaire (MSLQ) (see Table 2-2).

Table 2-2: Pintrich's Conceptual Framework with MSLQ Subscales

Phases and relevant scales	Areas for regulation			
	Cognition	Motivation/Affect	Behaviour	Context
Phase 1 Forethought, planning and activation	Target goal setting	Goal orientation adoption	Time and effort planning	Perceptions of task
	Prior content knowledge activation	Efficacy judgements	Planning for self-observations of behaviour	Perceptions of context
	Metacognitive knowledge activation	Perceptions of task difficulty Task value activation Interest activation		
Phase 2 Monitoring	Metacognitive awareness and monitoring of cognition	Awareness and monitoring of motivation and affect	Awareness and monitoring of effort, time use, need for help Self-observation behaviour	Monitoring changing task and contest conditions
Phase 3 Control	Selection and adaptation of cognitive strategies for learning, thinking	Selection and adaptation of strategies for managing motivation and affect	Increase/ decrease effort Persist, give up Help-seeking behaviour	Change of renegotiate task Change or leave context
Phase 4 Reaction and reflection	Cognitive judgements Attributions	Affective reactions Attributions	Choice of behaviour	Evaluation of task Evaluation of context
Relevant MSLQ Scales	Rehearsal Elaboration Organisation Critical thinking Metacognition	Intrinsic Goals Extrinsic Goals Task Value Control Beliefs Self-Efficacy Test Anxiety	Effort-Regulation Help-Seeking Time/Study-Environment	Peer Learning Time/Study-Environment

Note. From “A conceptual framework for assessing motivation and self-regulated learning in college students” by P.R Pintrich, 2004, *Educational Psychology Review, 16(4), 385-407 (p. 390)* (http://doi.org/10.1007/s10648-004-0006-x). Used with permission. © Springerlink.

2.4.3. Self-Regulated Learning Skills are Teachable

The models by both Zimmerman and Pintrich include the processes that learners go through alongside the competencies that they use during the process, as well as factors that may affect students' decisions about the use of the strategies. The use of these processes, strategies and skills has been repeatedly shown to contribute to academic success in a range of different domains (DiFrancesca et al., 2016; Lan, 1998). Both Pintrich (1995, pp. 7–9) and Zimmerman (2002, p. 69) have emphasised that these skills are learnable, with both authors also agreeing that use of the skills is not related to ability. The agentic nature of the underlying social cognitive theory (see Figure 2-2) assumes that neither motivations, nor learning strategies are traits of the learner. Motivation is dynamic and context-dependent, while "learning strategies can be learned and brought under control of the student" (Duncan & Mckeachie, 2005, p. 117).

2.4.4. Measuring Self-Regulated Learning Competencies

The literature presents a number of ways of measuring students self-regulated learning strategy use including self-report instruments, interviews, micro-analytical analysis, think aloud protocols and learning diaries. The choice of a method is partly dependent on the objectives of the measurements. After conducting a review of self-regulated learning measurement techniques and instruments, Roth et al. (2015) concluded that the self-report instrument known as the Motivated Strategies for Learning Questionnaire (MSLQ) provides a good balance between differentiated assessment and economical implementation and they consider that it measures motivation in a "very sophisticated manner" (Roth et al., p. 224). However, they believe that it does a poor job of assessing self-reflection, suggesting that the inclusion of interviews or additional scales would be prudent. While the metacognitive scale does measure some aspects of planning, monitoring and regulating strategies, it does not measure the intricacies of the cyclical nature of the process (Dunn, Lo, et al., 2012; Roth et al., 2015). The developers of the instrument did, however, find good predictive validity between the subscales and academic achievement (Pintrich et al., 1991). As such, the MSLQ is the most widely used measure of self-regulated learning motivations and learning strategy use (Panadero, 2017; Roth et al., 2015) and of academic self-efficacy (Honicke & Broadbent, 2016).

2.4.5. Self-Regulated Learning in Nurse Education

When investigating the use of self-regulated learning within a program of study, it is important to understand that students' ability and motivation to self-regulate are context dependent. Thus, students will have different motivations and strategies for different subjects within the program (Pintrich, 2004; Rovers et al., 2019; Sutcliffe, 1993). Therefore, measurement of motivation and strategy use should occur at the subject level rather than a more global year or program level, this is referred to as the level of granularity – or ‘grain size’ (Husmann et al., 2018; Pintrich, 2004).

Measurements of self-regulation within nursing students have occurred much less frequently than measurements of self-directed readiness, and occasionally the level of granularity of the investigation is unclear. Congruent with the wider education literature, self-efficacy has been found to be significantly correlated to academic performance, and within a bioscience context, self-efficacy of nursing students is relatively low (Andrew & Vialle, 1998; Chen et al., 2019). Lower achieving students use fewer of the learning strategies, and these are often strategies that promote surface level understanding (Andrew & Vialle, 1998; Bengtsson & Ohlsson, 2010). In addition, nursing students report low to moderate use of critical thinking skills (Andrew & Vialle, 1998; Keçeci, 2017; Salamonson et al., 2009). Furthermore, nursing students have been found to be primarily externally motivated, with their study strategies focused on passing the subjects to attain registration (Bengtsson & Ohlsson, 2010; Keçeci, 2017; Salamonson et al., 2009).These findings regarding use of learning strategies suggest that there is scope to provide support to students to improve their study skills. As noted above, ability to select and use study strategies is a pre-requisite for success in self-directed learning (Guglielmino, 1977; Knowles, 1975).

In broader self-regulated learning research, Zimmerman (2000a) notes that, novice learners tend to focus more on the performance phase and less on the forethought and self-reflection phases. While this has not yet been investigated with nursing students, Colthorpe and colleagues confirm this pattern with second-year allied health student (pharmacy, speech and physiotherapy) (Colthorpe et al., 2015, 2018, 2019a). That research also confirmed that those students who use strategies from all three phases, have higher academic achievement than those who rely on strategies from only one phase. Therefore, the literature suggests that promotion of the skills and strategies of the entire cyclical process of self-regulated learning may improve academic performance. In particular, providing support in the forethought phase – planning, task analysis; and the self-reflection phase – monitoring performance against comprehension and goal attainment; will improve students’ ability to be self-directed, life-long learners.

2.5. Conclusion

Students who are able to employ self-regulated learning processes often have higher academic achievement (DiFrancesca et al., 2016; Pintrich, 2002; Zimmerman & Moylan, 2009). However, according to Zimmerman (2001, p. 142) “self-regulation does not develop automatically with maturation nor is it acquired passively from the environment”. Therefore, to better prepare students for self-directed and lifelong learning, attention should be paid to developing students' metacognitive regulation of their learning through a self-regulated learning framework. In addition, training in the use of a variety of cognitive, metacognitive and resource management learning strategies should be included within the context of each of the subject domains to ensure that students have a repertoire of context-dependent strategies at their disposal. Indeed, as noted by Lan (1998, p. 93) "if we are convinced by research evidence that self-regulated learning strategies are beneficial and teachable to students, we should systematically implement instruction in self-regulated learning strategies at all levels of education"

3. Chapter 3: Literature Review

3.1. Abstract

Objectives: to systematically identify and summarise investigations of self-regulated learning strategy use amongst nursing and allied health students, with a focus on bioscience subjects.

Design: Narrative review

Databases: An online search of the following databases was undertaken: CINAHL, Scopus, ERIC (Proquest), Medline (OVID), PubMed, followed by a manual cascade search and Google Scholar cited (forward) search of articles selected for inclusion

Results: Ten articles were identified for inclusion. Two different techniques for measuring self-regulated learning strategy use were found: 1) self-report instruments and 2) thematic analysis of student descriptions of study techniques

Conclusions: Findings show that students in these professional health programs tend to be externally motivated, have low to moderate self-efficacy for learning biosciences and rely on a small number of learning strategies.

3.2. Introduction

Within nursing and allied health education, the study of biosciences has been an area of particular difficulty for students and academic underachievement in biosciences subjects can be a stumbling block to advancement within their program (Caon & Treagust, 1993; Craft et al., 2013; Jensen et al., 2018; McVicar et al., 2015; Wong & Wong, 1999). Much of the literature addressing this issue has focused on identifying factors that may be predictive of success within the biosciences, for example previous study of science and tertiary entrance score and self-efficacy for learning bioscience (Beauvais et al., 2014; Jensen et al., 2018; Wong & Wong, 1999). This has led to recommendations for higher tertiary entrance scores and pre-requisite science subjects for entry to nursing and allied health programs (Jensen et al., 2018; McVicar et al., 2015; Shulruf et al., 2011; Whyte et al., 2011). However, the perceived workforce shortage in some countries (Beauvais et al., 2014; Maurer et al., 2012; Olsen, 2017) means that these recommendations are not being followed, and in some instances, universities are admitting a wider range of students into nursing and allied health programs (McVicar et al., 2014, 2015; Taylor et al., 2015). Therefore, rather than limiting access to programs by requiring pre-requisites, educators need to look for ways to assist students admitted to nursing and allied health degree programs to improve their academic achievement in foundation bioscience subjects.

3.3. Background

Self-regulated learning (SRL) research has its origins in social cognitive theory, which has two important concepts for self-regulation in general: agency and self-efficacy. Agency is the ability of people to act and therefore, be contributors to and products of their life circumstances. Self-efficacy is the personal belief about one's capabilities to attain a goal (Bandura, 1997) and therefore affects the likelihood of choosing one behaviour over another (Bandura, 1982).

Self-regulated learning research has taken the principles of agency and self-efficacy and combined them with research on learning strategies, metacognition and motivation to apply them in a learning context (Greene, 2017). Several models of self-regulated learning have been developed. The two models most often cited are Zimmerman's (2000b) cyclical model and Pintrich's (2000, 2004) conceptual framework (Panadero, 2017). These and other models (e.g., M Boekaerts, 1997; Winne & Hadwin, 1998) of self-regulated learning show an iterative pattern guided by the principles of agency. Generally speaking, the models begin with a planning phase, which is followed by a performance phase and then an evaluative phase; these phases do not necessarily occur in a linear fashion; feedback from the performance and evaluative phases may cause changes as performance is occurring (Pintrich, 2000, 2004; Zimmerman, 2000b).

During the forethought phase, students deconstruct the task, set goals, and plan their strategies. Factors such as self-efficacy, outcome expectations, interest and goal orientation affect this phase (Zimmerman, 2000b, 2002). A range of strategies are undertaken in the performance phase, including the manipulation and transformation of learning materials to aid in understanding, the management of time and resources, and the management of motivation and procrastination (Dörrenbächer & Perels, 2016b). The self-reflection phase is where students determine if they are satisfied with the results and respond either adaptively or defensively (Dibenedetto & Zimmerman, 2013).

In early research using structured interviews focusing on cognitive, motivational and behavioural strategies of high school students, Zimmerman and Martinez-Pons (Zimmerman & Martinez-Pons, 1986, 1988) found that higher achieving students described using more "self-regulated learning strategies" than lower achieving students. The authors identified 14 commonly used self-regulated learning strategies, they combined into a SRL factor. This factor accounted for nearly 80% of the variance in achievement. It has since been suggested that students' ability to apply self-regulated learning strategies is predictive of their academic achievement (Pintrich et al., 1993; Zimmerman, 2002).

In a meta-analysis of 241 data sets collected over 13 years Richardson et al. (2012) investigated the relationship between the use of self-regulated learning strategies and academic achievement in higher education. They found small but significant correlations between four cognitive strategies representing deep learning and GPA (grade point average): metacognition, critical thinking, elaboration, and concentration; and between three behavioural strategies and GPA: time/study management, help seeking and peer learning. They also found medium positive correlations with effort regulation and grade goal, while self-efficacy was strongly associated with GPA.

Self-regulated learning skills can be learned and many have advocated for inclusion of instruction in self-regulated learning strategies in higher education (Dörrenbächer & Perels, 2016a; Paris & Paris, 2001; Pintrich, 1995; Schunk & Zimmerman, 1998). For this reason, a review of the literature was undertaken to establish what is known about self-regulated learning strategy use in nursing and allied health students.

The aim was to conduct a review of primary research on self-regulated learning within undergraduate nursing and allied health programs, in the biosciences, to describe what is known about how these students use self-regulated learning strategies. Therefore, the narrative review aims to answer the following questions:

1) What is currently known about self-regulated learning strategy use among nursing and allied health students studying bioscience?
2) What measurements of self-regulated learning have been employed to measure motivations and learning strategy use of nursing and allied health students studying bioscience?

3.4. Method

3.4.1. Search Methods

A preliminary search of Google Scholar was undertaken to identify relevant articles. From those articles key words were selected from the titles and abstracts to test in the indexes of Medline. It was noted that in some articles metacognition was used to refer to some of the skills associated with self-regulated learning, therefore it was included as a key word. In addition, self-efficacy is an important component of self-regulated learning and has previously been identified as being low in nursing students studying bioscience (Andrew et al., 2015), and so it was also included. Finally, the Motivated Strategies for Learning Questionnaire is a common instrument for measuring self-regulated learning strategy use, therefore MSLQ was also included as a key word. There were limited experimental investigations focussed on bioscience, therefore, the restriction was removed in additional searches to broaden the field to other academic subjects within nursing and allied health programs.

The final search was conducted using the following databases: Cumulative Index to Nursing and Allied Health (CINAHL); Scopus, ERIC, PubMed and Ovid Medline. The search terms were determined using the PICO model. The populations of interest (P) in this study were nursing and allied health students, therefore, the keywords used to search the databases were: “nurs*”, “allied health”, pharmacy and occupational therapy. This population was limited to those studying biosciences; therefore, the following search terms were included: bioscience* OR biological science* OR anatomy OR physiology. The phenomenon of interest (I) was self-regulated learning, and the following terms were used: “self-regulated learn*”; “study skill*”; “learning strateg*”; metacognit* and self-efficacy. Thus, the population was combined with the phenomenon for each search, for example: nurs* AND student* AND (bioscience* OR "biological science*" OR anatomy OR physiology) AND ("self-regulated learn*" OR "self-regulated learn*" OR metacognit* OR "study skill*" OR "learning strateg*" OR "self-efficacy" OR MSLQ). The searches included articles published up to and including 2019.

Limits were not placed on the search regarding comparisons (C) or outcomes (O) from the PICO model. Additional articles were identified through cascade searching of reference lists of the articles included and through forward citation searching of included articles using Google Scholar.

Table 3-1: Inclusion and Exclusion Criteria

Inclusion	Exclusion
Published in the English language	Not written in the English language
Peer reviewed	Not peer reviewed
Research articles	Not research articles
Undergraduate subjects, principally with bioscience focus	Undergraduate clinical skills subjects
	Related to post-graduate or professional development training
Peer reviewed articles related to the keywords	Articles not directly related to the keywords

3.5. Results

A summary of the aims and findings of the included articles is provided in Table 3-2.

Table 3-2: Summary of Included Articles

Author(s) & year	Aim/s	Setting and Sample	Methods/instrument	[1]Granularity	Key findings/recommendations
MEASUREMENT OF SRL: MSLQ					
1. Andrew & Vialle (1998) Australia	To examine relationships among self-efficacy, learning strategies and academic performance	303 1st year nursing students	SEFS, NASES, MSLQ (TV, SE, MC, CT)	Subject level Bioscience	• SE measures were all significantly related to overall academic performance • Metacognitive self-regulation was related to performance • Lower achievers used fewer learning strategies • Appear uncertain about "how" to study for science • Educators should increase students' SE, teach a range of learning strategies and make clear links between theory and practice
2. Chen et al. (2019) China	• To describe the levels of SRL ability, metacognitive ability and GSE among 2nd and 3rd year nursing students • To explore the relationship between SRL, MA and GSE • To compare SRL, MA and GSE between 2nd and 3rd year students	199 2nd and 3rd year	Two self-developed instruments • SRL (30 items) • MAS (24 items) Validated instrument • GSE (10 items)	Unclear – possibly year level	• Moderate levels of SRL and metacognitive ability • Low General Self-Efficacy (GSE)
3. Dunn et al. (2012) USA	Do pathophysiology students' causal attributions for ability, effort, context and luck	72 nursing pathophysiology students	MSLQ (GSL – Dunn et al, 2012a), MMCS	Subject level Bioscience	• Students causal thinking does affect the degree to which they self-regulated

	significantly influence their self-regulated learning?				• Educators should retrain students' maladaptive attributional tendencies explicitly
4. Kececi (2017) Turkey	To determine the self-regulation skills of nursing students on a health education course in a state university in Turkey To compare SRL skills of 2^{nd} and 3^{rd} year students	110 2^{nd} (52) & 3^{rd} (58) year	MSLQ	Unclear – possibly year level	• Principally externally motivated • Elaboration strategy was the most used • Significant difference between year levels • Males had higher control of learning beliefs than females
5. Robb (2015) USA	To examine the relationship between self-regulated approaches to learning, self-efficacy, independent study behaviours and GPA	65 senior-level nursing students in a nursing theory subject	MSLQ	Subject level Nursing Theory	• Students with high GPA may be more organised • Students with high self-efficacy use Elaboration strategies more
6. Salamonson et al. (2009) Australia	To explore SRL strategies used by first year medical and nursing students	565 first year nursing students 100 first year medical students	MSLQ (EG, CT, TEM, PL, HS)	Year level	• Significant differences between nursing and medical students • Nursing students o more extrinsically motivated o lower on all other scales
7. Salamonson et al. (2016) Australia	To examine the relationship between sense of coherence, self-regulated learning and academic performance	563 first year nursing students	Antonovsky's sense of coherence scale, MSLQ (Elaboration, Organisation, Rehearsal, SE, TV)	Year level	Main findings were in regard to sense of coherence (SOC) • Higher SOC predictive of higher grade • Higher SOC more likely to cope better with transition

Open-ended questions					
8. Colthorpe et al. (2015) Australia	To identify SRL strategies used	227 x 2nd year allied health students (speech & physiotherapy) (2015)	Evaluation of responses to a meta-learning task	Subject level Bioscience	• Those who used strategies from all phases of the SRL cycle perform better
9. Colthorpe et al. (2017) Australia	• To identify learning strategies used • To investigate the relationship between strategy use and academic achievement	231 x 2nd year allied health students (speech & physiotherapy) (2015)	Evaluation of responses to a meta-learning task	Subject level Bioscience	• These students were able to recognise and overcome their learning difficulties
10. Colthorpe et al. (2019b)	Reports on the use of meta-learning assessment tasks to gain insight into students' learning strategies and processes • Identify learning strategy repertoire • Determine interrelationships between quality of students' forethought and self-reflection strategies and academic performance	139 x 2nd year pharmacy students	Deductive thematic analysis of responses to meta-learning task	Subject level Bioscience	• Students had between 3 and 14 strategies o Most frequent = reviewing records o Least frequent = strategic planning and active reappraisal • 73% have used strategies from all three phases of the SRL cycle • 5% rely on strategies from all three phases – most "rely on" strategies from the performance phase

Note. Abbreviations: MSLQ – Motivated Strategies for Learning Questionnaire. Subscales of the MSLQ: TV – Task Value; SE – Self-efficacy; MC – Metacognition; CT – Critical Thinking; EG – Extrinsic Goal Orientation; TEM – Time/Environment Management; PL – Peer Learning; HS – Help Seeking; GSL – General Strategies for Learning. SEFS – Self-Efficacy for Science; NASES - Nursing Academic Self-Efficacy Scale; MAS – Metacognitive Ability Scale; GSE – General Self Efficacy Scale; LASSI – Learning and Study Skills Inventory. [1] granularity is the contextual level at which the MSLQ was used. It is designed to be used at the subject level but is often misused at year or program level.

3.6. Discussion

The literature that specifically related to self-regulated learning of nursing and allied health students was sparse. One of the difficulties in identifying appropriate literature was the failure of the papers to provide definitions for self-regulated learning. In some cases where self-regulated learning was mentioned, the context did not seem to fit with the theoretical underpinnings of self-regulated learning. In other words, the term 'self-regulated learning' may appear in the article, without reference to a definitive model of self-regulation. There was also some confusion in the literature between the use of the term 'self-regulated learning' and a related concept – 'self-directed learning'. In some instances these terms appear to have been used interchangeably (e.g., Örs & Titrek, 2018). Husmann et al. (2018) describe the difference between the two terms as being subtle, yet important. They suggest the relationship between the two is a matter of grain-size of analysis or granularity, with self-directed learning being the overarching concept, a more macro view of learning, while self-regulated learning has a more micro focus on the skills students use to achieve specific learning objectives, particularly in relation to cognition, metacognition, and motivation.

The way students self-regulate is context dependent, therefore, they will have different strategies for different subjects (Pintrich, 2004; Rovers et al., 2019; Sutcliffe, 1993). For example, they may have well-developed strategy use in one subject and poorly-developed strategy use in another. For these reasons, an appropriate level of granularity to examine when conducting self-regulated learning research is the subject level rather than the year, course or program level (Pintrich, 2004), and in some cases an even finer-grained approach may be preferred because the level of granularity will influence the accuracy of students' self-reports of their strategy use (Rovers et al., 2019). Zimmerman (1986, p. 307) notes that "self-regulation theory…focuses attention on ***how*** students personally activate, alter and sustain their learning practices in specific contexts". Self-directed learning readiness measures, on the other hand, tend to focus on a more global attitude to learning, meaning they may miss the nuances involved in attaining goals within a specific domain. Therefore, given the different focus of the two measures, articles measuring self-directed learning readiness will not be compared with those measuring self-regulated learning in the current review.

After reviewing each of the 10 papers deemed to be relevant to the research question, two categories of relevance were identified: 1) articles that directly measured self-regulated learning using survey instruments such as the MSLQ, and 2) those that measured self-regulated learning using open-ended questions in a descriptive manner. Each of these categories of research will now be discussed in turn.

3.6.1. Measuring Self-Regulated Learning

A range of measurement instruments and methods have been developed to assess students' use of self-regulated learning strategies. Measurement methods include the Zimmerman and Martinez-Pons (1986) self-regulated learning interview schedule (SRLIS); Pintrich et al.'s (1993) Motivated Strategies for Learning Questionnaire (MSLQ); and, Weinstein et al.'s (2002) Learning and Study Strategies Inventory (LASSI). The most comprehensive instrument for evaluating student self-regulated learning is Pintrich et al.'s (1993) Motivated Strategies for Learning Questionnaire (MSLQ) (Richardson et al., 2012) which assesses a student's cognition, motivation, metacognition and behaviour. In a review of self-report instruments, Roth et al. (2015) found that the MSLQ is also the most commonly used established instrument, used in 61% of studies, followed by the LASSI in 8%, and the remaining percentage shared between seven other instruments.

There were seven studies which provided sufficient data to describe various attributes of self-regulated learners within a range of cohorts using the following measurement instruments: the MSLQ; non-validated, self-developed questionnaires; and, open-ended questions (Table 3-2). In addition

Measuring Self-Regulated Learning Using Survey Instruments. The complete MSLQ, as developed by Pintrich et al. (1991) contains 81 items in 15 subscales. It is divided into 2 parts. The motivation part contains 6 subscales (self-efficacy for learning, task value, control of learning beliefs, extrinsic and intrinsic goal motivations, and test anxiety); while the learning strategies part contains 9 subscales, which can be further divided into cognitive strategies (rehearsal, elaboration, organisation and critical thinking) and metacognitive and resource management strategies (metacognitive, effort regulation, time and environment management, help seeking and peer learning). Pintrich et al. (1993) state that the subscales are modular and can be used individually. The items are rated on a seven-point Likert-type scale with 1 being "not at all true of me" and 7 being "very true of me" making a score of 4 neutral. Scores for all questions within a subscale are averaged to give a subscale mean. The questionnaire is designed to be administered at the subject level of granularity (Pintrich, 2004); however, it is often misused at a more overarching program level. In providing interpretation of the scores to students, Pintrich et al. (1993) state that a higher score is better than a lower one and consider 1, 2, or 3 to be low. The "higher" category was further divided into moderate (4) and high (5, 6 or 7) in the current study.

The complete MSLQ was used in only two studies Robb (2015) and Keçeci (2017). Robb (2015) reported that an increase in study time was positively associated with the use of rehearsal, elaboration and organisation strategies but did not present all the data or the comparative scores for the subscales. The means across all study times for the learning strategies are shown in Table 3-3 and range from 4.8 to 5.1. Therefore, on average, senior level nursing students were moderate to high for the use of these strategies in the nursing theory subject. Their self-efficacy was also moderate. Robb (2015) mentions relationships between self-efficacy and elaboration and between grade point average (GPA) and organisation but does not provide data.

Keçeci (2017) compared MSLQ measurements between second (n=52) and third year (n=58) nursing students, but the level of granularity was unclear. The means for all subscales were under 5 (Table 3-1), indicating moderate aptitude for the use of the learning strategies, and for self-efficacy. In addition, third year students scored higher on all scales and the difference was statistically significant in all scales except test anxiety and elaboration.

Four studies used a subset of the MSLQ (Andrew & Vialle, 1998; Dunn, Osborne, et al., 2012; Salamonson et al., 2009, 2016). Salamonson et al. (2009) compared the learning strategies of first year students in nursing (n=565) and medical (n=100) programs using one motivation scale (extrinsic goal orientation), one cognitive scale (critical thinking) and three resource management scales (time and study environment, peer learning and help seeking). They found significant differences between the two groups of students in all scales, with nursing students scoring higher on extrinsic motivation and lower on the rest of the scales (Table 3-3). They concluded that it may be difficult to co-teach these cohorts in a problem-based learning setting.

Salamonson et al. (2016) sought relationships between self-regulated learning and other factors in first year nursing (n=563) students. They used three cognitive scales (Rehearsal, Elaboration and Organisation) and two motivation scales (Self-efficacy and Task value) and the level of granularity was unclear. None of these subscales used are directly related to the cyclical processes of self-regulation described earlier, or to the management of resources such as time and effort, so it is not possible to make comment on the self-regulated learning skills of the students based on the chosen scales. However, the mean for the self-efficacy for learning scale ranged from 4.12 to 4.62 indicating a moderate level of self-efficacy, but again, the context is unclear. The task value scores were all over 5, indicating that students appreciate the relevance of the content being studied.

Dunn, Osborne et al. (2012) was interested in the effects of causal attribution on self-regulated learning within a pathophysiology subject. They focused on the performance control phase and self-reflection phase of Zimmerman's cyclical model (Zimmerman, 2000a), by modifying two subscales of the MSLQ (metacognition and effort regulation). This limits the comparability of the mean, which was 4.7, indicating a moderate level of self-regulation. Following analysis, they concluded that students' causal attribution of success or failure affects the degree of self-regulation, with attribution to ability having a greater effect than either luck or effort.

The study by Andrew and Vialle (1998) investigated self-efficacy, task value, metacognitive regulation and critical thinking in first year nursing students undertaking a bioscience subject. They made comparisons between different levels of achievement and found that lower achieving students scored lower on all four subscales. The lowest achieving students were below the mid-point (4, i.e., low) for all but task value. The highest performing students only scored marginally better with a mean of 4.9 for self-efficacy, 4.7 for metacognitive regulation and 4.3 for critical thinking, putting them in the moderate range for these subscales. In addition, during interviews, lower achieving students indicated that they had avoided science in high school and did not know how to study for science.

Overall, the data from descriptive studies using the MSLQ indicates that nursing students have low to moderate self-efficacy, low to moderate use of metacognitive and critical thinking strategies and high extrinsic goal orientation, even in instances where task value is high.

The final descriptive study (Chen et al., 2019) used two Chinese developed instruments to measure self-regulated learning and metacognition. The SRL scale was developed by Zhang and Li (2007, as cited in Chen et al. 2019) and includes subscales for learning motivation, self-management, cooperative learning, and information quality. The metacognitive scale was developed by Kang and Zhang (2005, as cited in Chen et al. 2019) and includes subscales for planning, monitoring, regulating, and evaluating. In addition, they used a validated *general* self-efficacy scale, which may be too broad to be a meaningful measurement. The use of these alternate scales makes it difficult to make comparisons to those studies using the MSLQ. The reason for their use of different scales may be the debate around the metacognitive scale of the MSLQ (Credé & Phillips, 2011; Dunn, Lo, et al., 2012; Hilpert et al., 2013). Pintrich et al. (1991) had expected the metacognitive scale to load onto several subscales, however, this was not the case. Pintrich (2004) notes that the MSLQ provides a starting place for future development of the scales to cover all aspects of the self-regulated learning cycle more fully. If the scales used by Chen et al. (2019) are validated, they may prove useful in the future. Using their instruments, Chen et al. (2019) concluded that second- and third-year nursing students had moderate levels of self-regulated learning and metacognitive ability and low general self-efficacy.

Table 3-3: MSLQ Subscale Means from Included Studies

Subscale	Kececi (2017)		Robb (2015)	Dunn, Osborne et al. (2012)	Salamonson et al. (2009)		Salamonson et al (2016)	Andrew & Vialle (1998)	Hardy (2013)
n =	52	58	65	72	565	100	563	162	103
Year level	2nd	3rd	4th	2nd	1st	1st	1st	1st	?
Granularity	Health Education		Nursing Theory	Pathophysiology (biosciences)	Nursing Program	Medical Program	Nursing Program	bioscience	2 biosciences combined*
Intrinsic	3.94 ± 1.12	4.82 ± 1.10							5.29 ± 1.06
Extrinsic	4.64 ± 1.31	5.24 ± 1.04			5.6	4.9			5.65 ± 1.11
Task Value	4.05 ± 1.09	4.90 ± 1.09					5.4	5.73	5.47 ± 1.14
Control Beliefs	3.86 ± 1.14	4.41 ± 1.03							5.61 ± 1.01
Self-efficacy	4.49 ± 1.06	4.93 ± 0.95	5.0				4.4	4.58	6.06 ± 1.01
Test Anxiety	2.85 ± 0.78	3.17 ± 1.07							3.95 ± 1.62
Rehearsal	4.14 ± 1.16	4.85 ± 1.05	5.1				4.6		5.69 ± 1.12
Elaboration	4.13 ± 1.34	5.11 ± 0.94	5.0				4.9		5.21 ± 1.04
Organisation	4.05 ± 1.32	5.00 ± 1.12	4.8				4.5		5.05 ± 1.27
Critical Thinking	4.00 ± 1.24	4.78 ± 0.97			4.2	4.5		4.00	3.77 ± 1.28
Peer Learning	3.83 ± 1.17	4.50 ± 1.38			3.6	4			4.95 ±0.89
Metacognition	4.09 ± 1.05	4.76 ± 0.62						4.55	5.53 ± 1.09
Effort Regulation	Missing	missing		4.7 ± 2.8					6.03 ± 0.90
Environment	4.13 ± 0.91	4.68 ± 0.64			4.7	5.1			4.03 ± 1.45
Help Seeking	3.89 ± 1.30	4.69 ± 0.86			4.1	4.4			3.05 ± 1.55

Note: no effect sizes were provided for any of the studies; * Fundamentals of biology for health technologies and Anatomical terminology. Mean ± standard deviation (where provided)

Measuring Self-Regulated Learning using Open-Ended Questions. In a series of articles Colthorpe and colleagues (2015, 2017, 2019b) used thematic analysis of meta-learning assessment tasks to identify self-regulated learning behaviour and specific cognitive learning strategy use by second year allied health students (physiotherapy, speech therapy, pharmacy). The meta-learning tasks consisted of a series of reflective questions that students submit every two to three weeks. Results from these studies show that those students who used self-regulated learning strategies from all phases of the cycle perform better than those whose strategies were all from the performance phase.

Colthorpe et al. (2015) developed a classification system for the student responses by combining Zimmerman's (2000a) three phases with the 14 commonly used self-regulated learning strategies identified during the structured interviews (SRLIS) of Zimmerman and Martinez-Pons (1986, 1988) and Nota et al. (2004). The forethought phase includes goal setting and strategic planning, while the self-reflection phase includes methods of self-evaluation. The rest of the common strategies were included in the performance phase and are concerned with organising and transforming the learning materials in some way, and managing resources such as time and environment, or assistance.

Students in these second-year subjects reported knowing a broad range of strategies, which Colthorpe et al. (2015 p. 148) suggests may be due to these students being "at an advanced stage of their education". However, the students tend to rely on only a narrow range (Colthorpe et al., 2019b), predominantly from the performance and self-reflection phases of the cycle, particularly 'reviewing records' (Colthorpe et al., 2015, 2017). Only 8% of physiotherapy and speech therapy students used strategies from the forethought phase (Colthorpe et al., 2015) and 5% of pharmacy students used strategies from all phases (Colthorpe et al. 2019b). The authors found positive significant relationships between a number of processes from the forethought and self-reflection phases and academic achievement.

Descriptive studies have been conducted across all year levels of students in nursing and with second year students in several allied health programs describing aptitude for some of the attributes of self-regulated learning using survey instruments and open-ended questions. The level of granularity is not always specified, making it difficult to make comparisons. When the granularity is reported, bioscience subjects are investigated more frequently than professional subjects.

The two different methods of collecting the data (the MSLQ instrument and the open-ended questions based on the SRLIS) provide slightly different insights into nursing and allied health students. However, there is not enough data to make generalisations. Both methods have the capacity to investigate cognitive, metacognitive, motivational and behavioural strategies. However, several authors note that the MSLQ does a poor job of assessing self-reflection and suggest that it would be prudent to include additional scales or interviews, or to modify scales (Dunn, Lo, et al., 2012; Hilpert et al., 2013; Roth et al., 2015). One benefit of the MSLQ over open-ended questions is that studies using the MSLQ should be comparable and could be part of a meta-analysis, while open-ended questions are often not standardised.

3.7. Conclusion

This review was conducted to clarify the following question: what is currently known about the use of self-regulated learning strategies among nursing and allied health students? The literature showed that more studies have been carried out with nursing students than with allied health students. Several studies have used self-report instruments to describe the propensity of nursing students to use various self-regulated learning strategies and have found that nursing students are more extrinsically motivated than intrinsically motivated and have a high reliance on surface learning strategies (Andrew & Vialle, 1998; Keçeci, 2017; Robb, 2015; Salamonson et al., 2009). None of the studies of nursing students discusses student characteristics in relation to the self-regulated learning cycle.

The studies by Colthorpe and colleagues (2019b) showed that while students have knowledge of a range of strategies, they tend to use only a few. Their conclusion that high-achieving students used strategies from all phases of the self-regulated learning cycle provides some direction for the development of suitable teaching strategies for nursing and allied health students. It would be prudent for educators to encourage, model and provide support for, the use of a breadth of strategies across all phases and across cognitive, metacognitive, motivational, and behavioural strategies.

3.8. Future Directions

This review aimed to address what is currently known about the use of self-regulated learning strategies among nursing and allied health students. This review found that the nursing and allied health educator could play a key role in directing the strategic use of self-regulated learning strategies by their undergraduate students.

Students within a cohort are not a homogenous group, so it would be useful to look for differences in the use of various strategies within the group. A useful comparison to make is how strategy use differs between high and low achieving students, given the early investigations by Zimmerman and Martinez-Pons (1986, 1988) and between high and low self-efficacy given the centrality of self-efficacy to social cognitive theory (Bandura, 1982). This may provide some insight into the types of interventions that may be of assistance to lower achieving students. For example, are they lacking in skills in all phases of the self-regulated learning cycle, or do they need a wider repertoire of information processing and transformation strategies?

4. Chapter 4: Does Nursing and Allied Health Students' Use of Self-Regulated Learning Strategies Change During a First Semester Undergraduate Bioscience Subject?: A Quantitative Research Study.

4.1. Abstract

Background: The use of self-regulated learning strategies has been correlated with higher achievement. The self-regulated learning literature suggests that some students can develop these skills over time without intervention. Biosciences have traditionally been difficult subjects for nursing students; therefore, knowledge of self-regulated learning strategy use within this domain may be useful in improving student achievement. The aim of this study was to determine how nursing and allied health students' self-regulated learning strategy use changes during a first-year, first-semester undergraduate bioscience subject (anatomy and physiology).

Design: Quasi-experimental study using a pre-test and post-test with a convenience sample

Settings: An Australian regional university.

Participants: First year undergraduate nursing and allied health students studying anatomy and physiology, hereafter referred to as their bioscience subject.

Methods: The Motived Strategies for Learning Questionnaire (MSLQ) was distributed to nursing and allied health students at the start and end of the first semester of their program's bioscience subject.

Results: There were 32 participants with matched questionnaires. Collectively, there were no significant changes overall in any of the subscales of the Questionnaire over the semester. However, when students were disaggregated by previous experience in higher education, there were statistically significant differences between the pre- and post-survey in almost all subscales, but particularly in self-efficacy and metacognitive regulation. Scores for those who had experience in higher education increased, while scores for those without experience decreased over the semester. In addition, lower achieving students used the cognitive and metacognitive learning strategies less than higher achieving students yet spent a greater amount of time studying.

Conclusions: Significant differences in many MSLQ subscales developed over the semester between students with and without previous higher education experience. In addition, lower achieving students were not using cognitive and metacognitive learning strategies effectively and may have had trouble identifying and using appropriate strategies.

Keywords: self-regulated learning, nursing students, allied health students, bioscience (4-8)

4.2. Introduction

The biosciences are an integral part of the nursing education programs worldwide. However, literature spanning from the advent of tertiary programs in nursing (Caon & Treagust, 1993) until more recently (McVicar et al., 2015; Shrestha et al., 2018) suggest that nursing students find bioscience subjects difficult, and that these subjects may be an impediment to progress within nursing programs internationally (Jensen et al., 2018). Importantly, success in the biosciences has been suggested to be predictive of success in nursing programs overall (Brown et al., 2017).

The depth of understanding of the biosciences needed by nurses is increasing because of factors such as the increase in life expectancy, along with the probability of older people having multiple diseases (co-morbidities), in addition to technological advances and increases in the range of duties undertaken by nurses (Birks et al., 2018; McVicar et al., 2014). Therefore, the ability to apply bioscience knowledge in a clinical setting is imperative, and an inability to do this has been correlated with poor patient outcomes (Aiken et al., 2014; Perkins, 2019). In addition, registered nurses report greater confidence in their clinical duties when they are able to draw on their bioscience knowledge (Montayre et al., 2021).

4.2.1. Background

Within the education literature, the use of self-regulated learning strategies has been shown to be correlated with achievement. The field of self-regulated learning stems from the social cognitive theory of Bandura (Bandura, 1982), which focuses on the agency of individuals to influence the course of their lives. There have been several models of self-regulated learning proposed (Pintrich, 2004; Winne & Hadwin, 1998; Zimmerman, 1989). The various models tend to agree that self-regulated learning is an iterative process of planning, performing, and evaluating one's actions towards a learning goal. In addition, most models discuss the skills and strategies required by students to undertake the process.

Self-efficacy is central to social cognitive theory, and subsequently self-regulated learning. Bandura describes self-efficacy as "people's belief about their capabilities to exercise control over events that affect their lives" (Bandura, 1991, p. 257) and notes that it is an important determiner of self-regulation to pursue goals. A student's self-efficacy will affect their motivation and behaviour and thus their choice of activity, the amount of effort they are willing to expend, and their persistence in the face of adversity (Bandura, 1991; Schunk & Dibenedetto, 2018). Accordingly, a students' self-efficacy is context-specific and is not necessarily consistent across all subject domains.

In addition, the cognitive strategies used by students to process new information also affect their success. Early learning strategies research identified cognitive strategies used by students for information processing and grouped them into rehearsal, elaboration and organisation strategies; as well as metacognitive strategies used for self-monitoring (Weinstein & Mayer, 1983). Pintrich and DeGroot (1990) concluded that the relationship between cognitive strategies and academic achievement is mediated by self-regulation. Pintrich et al. (1991) consolidated these areas of research into a self-report questionnaire called the Motivated Strategies for Learning Questionnaire (MSLQ) to assess the motivational orientations and cognitive and metacognitive strategy use of tertiary students. The questionnaire has been validated and confirmed to show promising correlations with academic performance (Pintrich et al., 1993). The MSLQ has since been the most widely used instrument in self-regulated learning measurement (Roth et al., 2015) and in self-efficacy measurement (Honicke & Broadbent, 2016).

In relation to the difficulties with biosciences, there are several characteristics of nursing students that have been investigated that are pertinent to self-regulated learning. For example, it has been found that nursing students have low self-efficacy for learning in the biosciences (Andrew et al., 2015). In addition, students in the earlier years of their educational program may not appreciate the relevance of bioscience knowledge to their clinical practice (Barton et al., 2021; Jordan et al., 1999). Nursing students have also been found to have high extrinsic goal motivation, and to rely more on surface learning strategies (Salamonson et al., 2009; Snelgrove, 2004) that aim to reproduce information rather than apply it (Virtanen & Lindblom-Ylänne, 2010).

In a study of undergraduate nursing students in a health education course, third year students scored higher in the MSLQ subscales than second year students (Keçeci, 2017). This suggests that over time, students develop some skills relevant to self-regulated learning. However, there is currently minimal research regarding nursing and allied health students' measurements of self-regulated learning using the MSLQ within a bioscience context, nor any information about whether this might change as they progress through their first semester of study. Therefore, the purpose of the current study was to explore commencing bioscience students' MSLQ scores over their first semester, and to investigate any potential influence of demographic factors.

The primary research question was: How do the self-regulated learning strategies of commencing nursing and allied health students change during one semester of undergraduate bioscience? To address this research question, there were three main sub questions: 1) do self-regulated learning strategies change from the beginning to the end of the first semester of study in foundation bioscience subjects? 2) are there any relationships between motivation and learning strategy use, and demographic factors? 3) are there any relationships between motivation and learning strategy use, and students' final grades?

4.3. Method

The current study used an observational pre-post design. The pre-semester survey was opened to students for 2 weeks, beginning in week 2, allowing time to have some experience with the subject prior to completing the questionnaire. The post-semester survey was opened to students for the final two weeks of teaching (weeks 12 and 13), before the completion of the final exam to capture current study techniques and perceptions in the lead up to the exam. To allow for matching of surveys and results, the participants were allocated a unique identification code, and identifying information was removed, as per the ethics approval (see 4.3.4 for details).

4.3.1. Participants and Settings

The study setting was one campus of a regional Australian university, for students enrolled in any of the first year, first-semester anatomy and physiology subjects offered in the nursing and allied health programs (occupational therapy, physiotherapy, sports and exercise sciences). Students were recruited via verbal notice during either lecture or practical sessions, and with a written notice containing the link to the online questionnaire, posted on the learning management system for each subject.

A total of 84 students completed the pre-survey; responses from 8 participants were removed because they could not be matched with the class list, leaving 76 participants. A total of 41 students completed the post-survey. 32 students had matching pre-semester and post-semester surveys. As the primary research question was to ascertain any differences from the beginning to the end of the semester, only these 32 students were included in the data analysis. Individual participants were not able to see the results of the MSLQ scores from the questionnaire until after the conclusion of the semester, to preserve the integrity of the post-semester survey.

4.3.2. Instrument and Data Collection

The Motivated Strategies for Learning Questionnaire (MSLQ) is a self-report instrument developed by Pintrich and colleagues (Pintrich et al., 1991). The MSLQ consists of 81 items in 15 subscales divided into two main parts: 1) motivation, containing six subscales and 2) learning strategy use with nine subscales, which can be further divided into cognitive strategies and metacognitive and resource management strategies. Item are rated on a seven-point Likert-type scale with 1 being "*not at all true of me*" and 7 being "*very true of me*". Scores for all items within a subscale are averaged to give a subscale mean. Motivations and strategy use are dependent on context. The literature shows that students used different strategies in different subject domains (Parpala et al., 2010; Sutcliffe, 1993). Therefore, when answering the items, students are asked to focus on what they would do specifically within the bioscience subject, not what they would do when learning in general.

Demographic information was collected at the start of the survey and consisted of age, gender, whether the student was the first in their family to attend university, whether the student had previous higher education experience, study load (Table 4-1), estimated hours of independent study and of paid work per week (Table 4-2). At the end of the semester, the grade for each of the participants was obtained from the university database and added to the data (Table 4-1). Students who achieved a grade of HD or D were considered to be higher achieving, while those who achieved a P or N were considered to be lower achieving.

4.3.3. Data Analysis

Data were analysed using SPSS Version 25. Matched data was analysed using paired t-tests. Levene's tests were carried out and assumptions for ANOVA were met. ANOVA were used to investigate the effect of demographic factors on achievement. ANCOVA was used to investigate the effect of demographic factors on the change in MSLQ subscale score over the semester. A Spearman's correlation was used to find the correlation between the changes in the subscales over the semester and achievement. In addition to reporting statistical significance (p value), the effect size was also reported using eta-squared (η^2) or Cohen's d, as appropriate Inter-item correlation (see Appendix D) and Cronbach's alpha were calculated as measures of internal consistency for each subscale. The alpha values obtained were consistent with those obtained in the development of the instrument (Pintrich et al. 1991). All subscales except help-seeking were within acceptable limits for Cronbach's alpha (DeVillis, 2012). The help-seeking subscale (along with several others) had less than four items within the subscale (see Appendix D), and thus, inter-item correlation is a better estimate of internal consistency. All subscales mean inter-item correlations were acceptable. However, three subscales (metacognitive self-regulation, time and environment management and help seeking) had negative lower values, suggesting that they are over broad constructs (Clark & Watson, 1995).

Ethics Approval

This study is part of a larger study that has Human ethics approval granted by the University Human Research Ethics Committee (H7611). Students were provided with informed consent information outlining the investigation, including the matching of data from the questionnaire to their final grades, and the use of the data generated. Only students who consented progressed to the next page of the online questionnaire. (Please see Ethics information in Appendix A and B).

4.4. Results

4.4.1. Demographics

The demographics of the 32 participants are summarised in Table 4-1. Most students were studying nursing (81% of participants). Just under half (43.8%) of students were considered school-leavers, being aged 19 and younger. The distribution of age groups within the participants was comparable with the subject cohort. Most students were the first in their family to attend university and were studying a full-time load. Approximately half of the participants had previous higher education experience. Overall, most students passed this subject.

Table 4-1: Demographics and End-of Semester Results of the Participants

Demographic	**Category**	**Count (%)** n=32
Age	0-19	14 (43.8)
	20-24	7 (21.9)
	25-29	2 (6.3)
	30+	9 (28.1)
Gender	Male	0
	Female	32 (100)
First in Family	Yes	20 (62.5)
	No	12 (37.5)
Previous Higher Education Study	Yes	17 (53.1)
	No	15 (46.9)
Study Load	2 subjects	3 (9.4)
	3 subjects	6 (18.8)
	4 subjects (full-time)	23 (71.9)
Field of study (A&P subject)	Nursing	26 (81)
	Occupational Therapy	3 (9.4)
	Sports & Exercise	3 (9.4)
	Physiotherapy	0
Grade Achieved *	HD >85%	7 (21.9)
	D >75% and <85%	7 (21.9)
	C >65% and <75%	3 (9.7)
	P >50% and <65%	12 (37.5)
	N <50%	3 (9.7)

* HD = High Distinction, D = Distinction, C = Credit, P = Pass, N = Not satisfactory

Table 4-2: Hours of Independent Study and Paid Employment of the Participants

	Number of participants (%) n=32	
	Pre-semester survey	Post-semester survey
Study hours		
<4	6 (18.8)	1 (3.1)
4-6	12 (37.5)	16 (50)
7-10	9 (28.1)	3 (9.4)
>10	5 (15.6)	12 (37.5)
Employment hours		
0	10 (31.3)	16 (50)
1-9	4 (12.5)	1 (3.1)
10-19	9 (28.1)	7 (21.9)
20-29	5 (15.6)	4 (12.5)
>30	4 (12.5)	4 (12.5)

The university recommends 10 hours of study per week for 3-point subjects, including both contact hours and independent study time. The anatomy and physiology subjects in this study had 5 contact hours per week (three x 1-hour lectures and one x 2-hour practical or workshop); therefore, students were expected to spend an additional 5 hours per week on independent study. Approximately one third of students reported spending 4-6 hours a week on independent study at the start of the semester, which increased to half of the respondents at the end of the semester (Table 4-2). Fifteen percent of students reported spending more than 10 hours a week, increasing to more than one third at the end of semester. Higher achieving students tended to spend the recommended number of hours studying per week, while lower achieving students reported spending a greater number of hours per week.

4.4.2. Motivated Strategies for Learning Questionnaire Scores

Change From Beginning to End of Semester. Data from the matched pre-semester and post-semester MSLQ surveys showed no statistically significant changes in any of the subscales (Table 4-3). The lowest scores in both the pre-semester and post-semester survey were for critical thinking, which were below 4 indicating that it was not often used. Extrinsic goal orientation was considerably higher than intrinsic goal orientation at both the beginning and end of the semester. Effort regulation decreased from the beginning to the end of the semester. There was a general trend for the use of the cognitive learning strategies to increase over the semester.

The change in each subscale was calculated by finding the difference between the end of semester score and the beginning of semester score for each participant. A correlation analysis shows the relationships between this change in each subscale over the semester, along with subscale correlation with the final grade (Table 4-4). There were significant moderate correlations between the final mark and eight of the 15 subscales (Intrinsic, self-efficacy, control of learning, elaboration, organisation, critical thinking, metacognition and time and environment management).

The strongest correlation with final grade was with self-efficacy ($\rho=0.666$, $p<=0.01$). The change in self-efficacy over the semester was also positively correlated with final mark. Higher achieving students' self-efficacy increased over the semester (HD = 5.0 to 5.6), while lower achieving students' self-efficacy either remained the same or decreased (N = 4.5 to 3.2). This indicates that by the end of the semester higher achieving and failing students had a realistic perception of their ability. However, passing grade students had a relatively low self-efficacy (3.5). Overall, increases in self-efficacy were correlated with increases in metacognitive learning strategies, along with organisation and critical thinking, but not significantly correlated with changes in rehearsal or elaboration strategies (Table 4-4).

There were significant, moderate-to-strong positive correlations between the cognitive learning strategies. This indicates that an increase in the use of one of these strategies was accompanied by an increase in the use of the others. Increases in metacognitive regulation were also strongly correlated with increases in the use of the cognitive learning strategies, and with time and environment management.

Factors Affecting the Change in MSLQ Scores. Previous experience in higher education was the only demographic factor (Tables 4-1 & 4-2) to have a statistically significant effect on MSLQ scores, and this occurred for 12 of the 15 subscales (see Table 4-5). The largest effect sizes were for self-efficacy ($\eta^2=0.511$) and metacognitive regulation ($\eta^2=441$). The difference was caused by a simultaneous increase for students with previous university experience and a decrease for the students with no previous university experience.

Factors Affecting Achievement. The only factor that had a statistically significant effect on achievement was previous higher education experience ($p=0.004$). Those students with previous university experience were more likely to receive a higher grade (>75%) than those without previous experience. In addition, students with previous higher education experience were more likely to improve their MSLQ subscale scores over the course of the semester (Table 4-5), suggesting that an increase in MSLQ scores was correlated with an increase in achievement.

Table 4-3: Analysis of Participant Responses to the Motivated Strategies for Learning Questionnaire from Pre-Semester to Post-Semester

		Subscale	Pre-semester		Post-semester		r	p	Trend	Cohen's d	Cronbach's α
			Mean	SD	Mean	SD					
Motivation		Intrinsic	4.8	1.20	4.9	1.08	0.413	0.549	↑	0.081	0.68
Motivation		Extrinsic	5.7	1.27	5.6	1.06	0.407	0.707	↓	0.078	0.77
Motivation		Self-Efficacy for Learning	4.3	0.95	4.3	1.31	0.590	0.791	→	0.000	0.93
Motivation		Control of Learning Beliefs	5.8	1.01	5.9	0.85	0.424	0.761	↑	0.099	0.75
Motivation		Task Value	6.0	1.07	6.0	0.87	0.311	0.980	→	0.000	0.89
Motivation		Test Anxiety	5.4	1.35	5.2	1.25	0.354	0.637	↓	0.135	0.86
Learning Strategies	Cognitive	Rehearsal	4.7	1.48	5.1	1.12	0.453	0.103	↑	0.287	0.76
Learning Strategies	Cognitive	Elaboration	4.9	1.37	5.1	1.27	0.574	0.298	↑	0.164	0.86
Learning Strategies	Cognitive	Organisation	4.6	1.43	5.0	1.25	0.449	0.109	↑	0.283	0.76
Learning Strategies	Cognitive	Critical Thinking	3.7	1.39	3.9	1.31	0.197	0.450	↑	0.117	0.78
Learning Strategies	Cognitive	Peer Learning	4.3	1.71	4.6	1.38	0.726	0.304	↑	0.253	0.65
Learning Strategies	Metacognitive	Metacognitive Regulation	4.5	1.12	4.6	1.02	0.451	0.484	↑	0.089	0.81
Learning Strategies	Metacognitive	Effort Regulation	5.1	1.14	4.7	1.17	0.407	0.072	↓	0.318	0.70
Learning Strategies	Metacognitive	Time & Environment	4.9	1.11	4.9	0.95	0.637	0.941	→	0.000	0.78
Learning Strategies	Metacognitive	Help seeking	4.4	1.38	4.3	1.23	0.624	0.646	↓	0.088	0.57

Note. (n=32); Cronbach's α calculated using all cases pre and post and represents one measure of internal consistency of each subscale. 0.70 is regarded as an acceptable level for Cronbach's alpha. A low number may indicate that the scale is too broad, while a very high number may indicate that redundant items are included (Tavakol & Dennick, 2011) SD = standard deviation

Table 4-4: Spearman's Rho Correlation Matrix. Correlation Between the Change in the Subscales over the Semester and Final Mark

		^Final mark	Final Mark	Motivation subscales						Learning strategy subscales								
				IN	EX	SE	CL	TV	TA	RH	EL	OR	CT	PL	MR	ER	TE	HS
Motivation subscales	Intrinsic (IN)	0.406*	-0.024	1.000														
	Extrinsic (EX)	0.291	0.100	0.487**	1.000													
	Self-efficacy for Learning (SE)	0.666**	0.454**	0.429*	0.160	1.000												
	Control of learning beliefs (CL)	0.405*	0.097	0.556**	0.317	0.394*	1.000											
	Task Value (TV)	0.302	0.063	0.562**	0.448*	0.372*	0.710**	1.000										
	Test Anxiety (TA)	-0.315	-0.052	0.596**	0.478**	0.142	0.341	0.402*	1.000									
Learning strategy subscales	Rehearsal (RH)	0.294	0.014	0.237	0.369*	0.333	0.511**	0.538**	0.149	1.000								
	Elaboration (EL)	0.496**	0.125	0.452**	0.257	0.332	0.379*	0.427*	0.197	0.668**	1.000							
	Organisation (OR)	0.499**	0.219	0.297	0.307	0.453**	0.320	0.300	0.218	0.628**	0.657**	1.000						
	Critical Thinking (CT)	0.389*	0.128	0.561**	0.266	0.578**	0.429*	0.456**	0.199	0.461**	0.715**	0.709**	1.000					
	Peer Learning (PL)	0.156	-0.066	0.361*	0.326	0.336	0.194	0.265	0.230	0.356*	0.282	0.431*	0.325	1.000				
	Metacognitive Regulation (MR)	0.498**	0.312	0.565**	0.263	0.752**	0.465**	0.490**	0.214	0.626**	0.719**	0.739**	0.793**	0.373*	1.000			
	Effort Regulation (ER)	0.250	-0.003	-0.036	0.150	0.107	0.049	0.131	-0.056	0.498**	0.386*	0.397*	0.233	0.107	0.330	1.000		
	Time & Environment (TE)	0.440*	0.219	0.440*	0.225	0.506**	0.285	0.359*	0.261	0.594**	0.632**	0.718**	0.640**	0.359*	0.761**	0.499**	1.000	
	Help Seeking (HS)	0.335	0.039	0.225	0.305	0.390*	0.395*	0.250	0.401*	0.276	0.177	0.275	0.216	0.447*	0.279	0.091	0.178	1.000

Note. (n=32) *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed). [^first column is correlation between final mark and post-semester score]

Table 4-5: ANCOVA of the Effect of Previous Study on The Change in the Subscales

Subscale			No previous university					Previous university					ANCOVA		
			Pre-semester		Post-semester		Trend	Pre-semester		Post-semester		Trend	F	p	η^2
			Mean	SD	Mean	SD		Mean	SD	Mean	SD				
Motivation		Intrinsic	4.4	1.00	4.3	0.92	↓	5.2	1.25	5.5	0.91	↑	6.644	0.008	0.222
		Extrinsic	5.8	0.85	5.3	1.10	↓	5.5	1.57	5.9	0.96	↑	4.606	0.040	0.137
		Self-Efficacy for Learning	3.9	0.91	3.3	0.95	↓	4.6	0.88	5.2	0.78	↑	30.281	0.000	0.511
		Control of Learning Beliefs	5.7	0.85	5.4	0.87	↓	6.0	1.14	6.3	0.63	↑	8.805	0.006	0.233
		Task Value	5.9	0.92	5.6	0.98	↓	6.1	1.21	6.4	0.57	↑	7.141	0.012	0.198
		Test Anxiety	5.7	1.05	5.7	1.07	→	5.0	1.54	4.8	1.31	↓	2.260	0.144	0.072
Learning Strategies	Cognitive	Rehearsal	4.6	1.50	4.6	1.26	→	4.7	1.51	5.5	0.78	↑	7.279	0.012	0.201
		Elaboration	4.7	1.36	4.5	1.28	↓	5.0	1.41	5.7	0.99	↑	9.845	0.004	0.253
		Organisation	4.6	1.52	4.3	1.16	↓	4.7	1.40	5.7	0.99	↑	14.740	0.001	0.250
		Critical Thinking	3.8	1.38	3.2	1.06	↓	3.5	1.42	4.5	1.25	↑	10.263	0.003	0.261
		Peer Learning	4.3	1.65	4.3	1.26	→	4.3	1.81	4.8	1.49	↑	1.801	0.190	0.058
	Metacognitive	Metacognitive Regulation	4.4	1.17	4.0	0.92	↓	4.6	1.07	5.3	0.68	↑	22.839	0.000	0.441
		Effort Regulation	5.0	1.16	4.2	1.35	↓	5.2	1.14	5.1	0.82	↓	4.639	0.040	0.138
		Time & Environment	4.5	1.14	4.4	0.82	↓	5.2	1.00	5.3	0.85	↑	6.111	0.020	0.174
		Help seeking	4.0	1.38	3.8	1.37	↓	4.7	1.34	4.7	0.95	→	2.456	0.128	0.078

Note. SD = Standard deviation; df 1,29

4.5. Discussion

4.5.1. Changes in MSLQ Over the Semester

The main finding of the current study is that there were no significant changes in any of the subscales across the cohort as a whole. Overall, these nursing and allied health students had much higher extrinsic goal orientation than intrinsic, and they showed moderate self-efficacy for learning bioscience. They had high control of learning beliefs and task value scores. As a group, they appear to be using the three main classes of information-processing cognitive learning strategies of rehearsal, elaboration, and organisation. However, they have poor use of critical thinking skills, and their use of the metacognitive strategies was moderate.

Nursing and allied health students have previously been found to be more extrinsically motivated than intrinsically and more likely to use surface learning strategies (Maurer et al., 2012; Salamonson et al., 2009), which was consistent with the results of the current study. Furthermore, in this study, extrinsic goal orientation was not significantly correlated to achievement and rehearsal was the only cognitive strategy with a significant correlation to extrinsic motivation. The overuse of surface learning strategies, such as rehearsal, is not efficient in a bioscience context, particularly where information must be integrated for clinical problem-solving in the future (Johnston et al., 2015). Two possible reasons that students may use surface strategies is the volume of content in bioscience subjects (Sand-Jecklin, 2007) and the type of assessment tasks given to students, such as multiple-choice questions (Snelgrove, 2004).

The subscale with the highest score was task value. The task value construct is related to expectancy value theory and is composed of three types of value: interest, importance and utility (Eccles & Wigfield, 2016). Therefore, the high scores in this study suggest that these nursing and allied health students find biosciences important and useful to their program, even when their self-efficacy for the content is low. Self-efficacy and relevance of bioscience content have long been suggested as being major contributors to the ‘bioscience problem’ (Andrew et al., 2015; Jordan et al., 1999). With regards to the literature on relevance of content, the current study is consistent with more recent literature that has reported that nursing students appreciate the importance of bioscience knowledge to their future career (Barton et al., 2021; Birks et al., 2018; Montayre et al., 2021). This shift in attitude of nursing students to the relevance of biosciences may be due to the effort of educators to implement the recommendations of earlier research to include more links between the content and the clinical setting (Logan & Angel, 2014; Mortimer-Jones & Fetherston, 2018). However, an appreciation of relevance does not appear to lead to a high self-efficacy score or greater achievement. Consequently, it remains important to consider teaching approaches that support the use of more advanced cognitive and metacognitive learning strategies by these students in their bioscience studies.

4.5.2. Factors Affecting the Changes in MSLQ and Achievement

There were statistically significant differences between those students who had previous experience in higher education and those who did not, both in terms of scores in the MSLQ (particularly self-efficacy and metacognitive regulation) and in achievement. Irvine et al. (2021) obtained similar results with beginning students in a block mode professional studies nursing subject. In addition, this is consistent with studies that show higher MSLQ scores for students in later years of their programs (e.g. Keçeci, 2017) and also with studies that show higher self-directed learning readiness as students' progress through their program (e.g. Slater & Cusick, 2017). It suggests that successful students are able to develop their repertoire of learning strategies, and apply them when and how they are needed, as was originally described by Zimmerman and Martinez-Pons (1986).

However, in this study, those students with no prior experience showed a decrease in MSLQ scores over the semester, which is a cause for concern. The differences in self-efficacy and metacognitive regulation between the two groups are likely to be moderators of the observed trends in the use of the cognitive and metacognitive learning strategies (Bandura, 1993; Pintrich & De Groot, 1990). The greatest modifier of self-efficacy is experience, success is likely to increase self-efficacy and early assessments where students can have some successes have been advocated as one method of increasing self-efficacy (Bartimote-Aufflick et al., 2016; Schunk & Dibenedetto, 2018; Schunk & Pajares, 2009). However, negative experiences can be either motivating or discouraging, depending on other factors (Bandura, 1991). The current study also found that, while low achieving students are reporting a greater amount of time spent on studying, they are not identifying more strongly with any of the learning strategies presented in the questionnaire. One potential reason for this may be that they were not metacognitively aware enough to identify the study strategies that they are using (Lukes et al., 2020). This lack of metacognitive awareness will also contribute to poor use of the entire self-regulated learning cyclical process, and thus to poor student outcomes (Lukes et al., 2020).

4.6. Conclusion

There is strong research evidence to suggest that self-regulated learning strategy use is linked to higher achievement in a range of disciplines. The nursing and allied health students in this study had MSLQ scores in the low-to-moderate range in a bioscience context. While there was no overall change in the MSLQ scores across the semester, disaggregating the students into those with prior higher education experience and those without revealed that students transitioning into higher education in nursing and allied health were likely to decrease in self-efficacy, motivation and cognitive and metacognitive strategy use as the semester progressed. This could mean that they are potentially even more unprepared for further study in biosciences. To assist nursing and allied health students to develop their learning strategy repertoire and use, educators need to make time to develop their declarative knowledge of strategies and conditional knowledge of when and how to use them.

4.7. Limitations and Future Research

This study has several limitations. The first is that it is a relatively small sample of students from a single university. The second is that the data collection relies on a self-report instrument. There has been some criticism of the accuracy of student recollection for self-reporting and the possibility that students will select socially acceptable answers.

Follow up studies are required to confirm the decreases in MSLQ subscales of students without prior university experience. These studies would benefit from a qualitative component to derive a more complete picture of the phenomenon.

5. Chapter 5: Development of an Intervention to Integrate Self-Regulated Learning Strategies Within a Core Bioscience Subject for Diploma Students in Nursing and Allied Health.

5.1. Abstract

This chapter describes the development and implementation of a learning intervention that integrates the explicit instruction of the use of self-regulated learning strategies with the teaching of core foundation concepts in biosciences to nursing and allied health students. Literature about the characteristics of nursing students influenced the selection of the self-regulated learning framework, which focusses on the processes and strategies that are used by high achieving students to achieve their academic goals. Self-regulated learning is a cyclical process (phases) of using cognitive, metacognitive and resources management strategies (learning strategies). Therefore, the bioscience content was divided into modules, which were delivered in a learning cycle format containing forethought, performance and self-reflection phases that were modelled by the instructor. Within each phase, evidence-based learning strategies were matched with content concepts to provide optimal opportunities for students to practice the strategies. Following instruction, students had declarative, procedural and conditional knowledge of the phases and the learning strategies, which they could use during their independent study time. The benefit of this integrated instruction is that students who need support but would not otherwise seek it are exposed to the techniques in context, which may assist in conveying their usefulness.

5.2. Introduction

It has been persistently reported in the literature, over more than two decades, that nursing students, and more recently, allied health students experience difficulties with the bioscience subjects within their professional programs. Several reviews of the literature have been conducted to investigate the factors that may affect nursing student achievement in the biosciences (Jensen et al., 2018; McVicar et al., 2014, 2015). McVicar et al. (2015) show that factors such as pre-requisites and teaching methods are inconsistently associated with success. However, student study skills are repeatedly highlighted as an area where improvements may provide benefits (Barker et al., 2016; Caon & Treagust, 1993; Cox & Crane, 2014; Davies et al., 2000; Mckee, 2002; Nicoll & Butler, 1996; Timmins, 2008). McVicar et al. (2015, p. 500) concluded that while it may be beneficial to introduce science pre-requisites for entry to nursing programs, success will still “likely be contingent on innovative support early in Year 1 for study skills and the fundamentals of human bioscience”. Similarly, Ralph et al. (2017, p. 586) note that “a persistent lack of strategies for learning and teaching this content in nursing hinders educational development in this important area”. In addition, there has been a decline in the requirement of science pre-requisites in Australian universities since the 1990s. Currently, only 28% of health and medical programs (excluding nursing and midwifery) nationwide require any science subject for entry (Finkel et al., 2020). Indeed, it is important to consider that it is unlikely that pre-requisites will be reinstated and that universities should expect first-year student with differing levels of preparedness (Finkel et al., 2020). Therefore, addressing aspects within the bachelor's degree, rather than pre-requisite subjects, appears to be the most effective way of addressing nursing and allied health students' challenges with biosciences.

Education research, more generally, reports causal relationships between the use of cognitive and metacognitive learning strategies and academic achievement (Hattie & Donoghue, 2016). However, students do not always spontaneously acquire the skills of using these learning strategies and may need additional focussed instruction in this area (Donker et al., 2014; Usher & Schunk, 2018). Surveying the nursing education literature after the above reviews did not reveal any descriptions of studies or interventions targeting study skill development within the biosciences for either nursing or allied health students.

Therefore, the aim of this chapter is to describe the development of a learning intervention to develop students' self-regulated learning skills within the context of learning bioscience. The self-regulated learning framework has been selected over the self-directed learning framework. The self-directed learning framework is regularly used in a nursing education context and entails learners taking responsibility for their own learning goals and tasks, with limited direction from academics. Self-regulated learning, on the other hand, has a focus on the processes and skills required to enhance achievement, while also considering the effect of student motivations towards learning. Pintrich (2000, p. 453) defines self-regulated learning as "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate and control their cognition, motivation and behaviour, guided and constrained by their goals and the contextual factors of the learning environment".

This chapter will discuss some of the characteristics of beginning nursing students as learners that have been presented in the literature, and how these learner characteristics have affected the design of the current intervention. Following that, the theoretical framework for the development of the current intervention will be presented. This includes both self-regulated learning theory and learning strategy theories pertaining to specific cognitive, metacognitive and resource management strategies that have empirical support for benefiting students' information processing, memory, and self-regulation. Then, the specifics of the current intervention will be discussed. The chapter uses the Cre-DEPTH criteria (Van Hecke et al., 2020) to ensure inclusion of all relevant information (Appendix F-1).

5.3. Characteristics of Beginning Nursing Students

When designing a learning intervention, it is important to understand the characteristics of the students who will be undertaking the learning. The characteristics of nursing students as learners have been studied both within nursing programs generally, and within biosciences more specifically. More generally, it has been reported that nursing students are not ready for self-directed learning (Barker et al., 2016; Bingen et al., 2019; Slater & Cusick, 2017). In addition, when compared to teaching or social science students, nursing students self-directed learning readiness was lower, and they had a higher preference for authoritative direction (Boström & Hallin, 2012; Turunen et al., 1997).

Within the bioscience context, it has been reported that nursing students find studying for biosciences time consuming and anxiety provoking (Craft et al., 2013; Friedel & Treagust, 2005; Jordan et al., 1999). The literature shows that they can be open to a range of teaching modalities, but their preference is for instructors to provide answers, particularly through didactic methods rather than through flipped learning (al-Modhefer & Roe, 2010; Butzlaff et al., 2018). One reason for this preference within this subject context may be their lack of confidence in their knowledge and understanding, due to the content-heavy, conceptually challenging nature of the subject matter (Jordan et al., 1999; Michael, 2007). Indeed, nursing students' perceived self-efficacy for learning biosciences has been reported as being generally low (Andrew et al., 2015; McVicar et al., 2014). In a preliminary study for the current intervention, nursing students without prior experience in higher education reported a decrease in self-efficacy for biosciences over their first semester of bioscience study (Chapter 4). It has also been noted that nursing students tend to rely on surface learning strategies, with the aim of reproducing information for the examinations (Sand-Jecklin, 2007; Snelgrove, 2004). The tendency of students to want information to be provided by an authoritative other is common in the dualism phase of intellectual development, as described by Perry (in Love & Guthrie, 1999), where students are under the impression that they should learn the right answers and that these come from authorities. This phase of development is not uncommon in beginning tertiary students. In addition, this belief should not be surprising in a science context, given that compulsory secondary school science is most often experienced as a 'body of knowledge' (Duggan & Gott, 2002; Hume & Coll, 2010; Tytler, 2020), after which, many future nursing students choose to avoid elective senior secondary school science (Andrew & Vialle, 1998).

However, despite finding biosciences difficult, nursing students are appreciative of the importance of the biosciences to their future clinical practice (Birks et al., 2013; Montayre et al., 2021) and regularly report that they would like more instructional time spent on biosciences (Craft et al., 2017; Davis, 2010).

5.4. Theoretical Framework for the Intervention

Self-efficacy and self-regulation are both components of Bandura's (1982, 1991; Zimmerman et al., 1992) social cognitive theory. Bandura (1982) asserts that there are four main sources of self-efficacy beliefs: the first is mastery experiences, where the student experiences success; the second is through vicarious experiences, by observing peers succeeding; third is through verbal persuasion, which involves credible feedback from instructors; and finally emotional and physiological states can boost or undermine performance, for example, anxiety can decrease perceived self-efficacy. Schunk and Ertmer (2000, p. 643) recommend that "programs designed to teach self-regulation include components to enhance student's self-efficacy for learning and implementing self-regulation skills" because they found that these two factors can exert reciprocal effects. Bandura (1977, 2012) also reports that students can learn socially through observation, and imitation of modelling. Therefore, the educational strategies used in the current intervention rely heavily on modelling by the instructor, and collaborative learning in informal small groups during practical sessions (Pintrich, 1995; Sanders & Welk, 2005). Modelling is a process of making expert thinking visible. The concept of modelling is also considered an important part of cognitive apprenticeship theory, which has similar aims of increasing students' use of cognitive and metacognitive processes (Lyons et al., 2017).

The aim of early self-regulated learning research was to identify and understand the skills, processes and attitudes of high achieving students and how they differ from low achieving students (Corno, 1994). The early work of Zimmerman and Martinez-Pons (1986) identified 14 strategies used by high achieving students (see Table 5-1 for list of strategies) to achieve their learning goals. The authors combined these strategies into a self-regulation "factor", which they report accounted for 80% of the variance in achievement in a regression analysis (Zimmerman & Martinez-Pons, 1986). While *self-directed learning* researchers have debated whether self-directed learning is a personality trait or skills that can be taught (Slater & Cusick, 2017), *self-regulated learning* researchers contend that there are self-regulated learning strategies and skills that can be taught to students, and that doing so can lead to improvement in academic achievement (Pintrich, 1995; Zimmerman, 2002).

While there are a number of models of self-regulated learning (Panadero, 2017), the current intervention includes aspects of the 3-phase cyclical model of self-regulation by Zimmerman (Zimmerman, 1998, 2000a; Zimmerman & Moylan, 2009) and the conceptual framework of Pintrich (2000, 2004). There is considerable overlap between these two models, because both are grounded in social cognitive theory.

Zimmerman was one of the early self-regulated learning researchers and began developing his model in the late 1980s (Panadero, 2017). In 2000, Pintrich attempted to consolidate all of the models presented at the time, while also identifying the important role of motivation in self-regulated learning (Panadero et al., 2017; Pintrich, 2000). Pintrich was also involved in the development of one of the most widely used instruments to measure self-regulated learning, the Motivated Strategies for Learning Questionnaire (MSLQ; Panadero, 2017; Pintrich et al., 1991) prior to research interest in self-regulated learning (Pintrich, 2004). The MSLQ contains constructs based on other important educational theories including learning strategies theory (Weinstein & Mayer, 1983; Weinstein & Meyer, 1991), and motivational theories such as expectancy-value beliefs and affect (see Pintrich, 1999 for discussion). When consolidating the available models, Pintrich categorised the 14 learning strategies identified by Zimmerman and Martinez-Pons (1986) using Weinstein's categories.

Therefore, the current intervention was structured around the three phases of Zimmerman's cyclical model: forethought, performance and self-reflection (Zimmerman & Moylan, 2009) and included explicit instruction of cognitive, metacognitive and resource management strategies as outlined in Pintrich's (2000, 2004) conceptual framework), within the context of the bioscience content. In addition, student-centred teaching strategies were used to maximise the self-motivational beliefs of Pintrich's framework (e.g., intrinsic or extrinsic motivation, control of learning beliefs, task value and self-efficacy for learning).

5.5. Intervention Development Process

Self-regulated learning encompasses the use of cognitive, metacognitive and resource management strategies across a cyclical process of forethought, performance and monitoring, and self-reflection to reach one's learning goals. This informed the current intervention in two ways. First, each module of content was taught as a "learning cycle"; namely, there was a forethought phase, a performance phase, and a self-reflection (which I have called self-evaluation to the students) phase for each module. Second, within each phase, explicit instruction in cognitive, metacognitive and resource management strategies was embedded within the bioscience content. Therefore, the process of intervention design followed these steps as outlined in Figure 5-1.

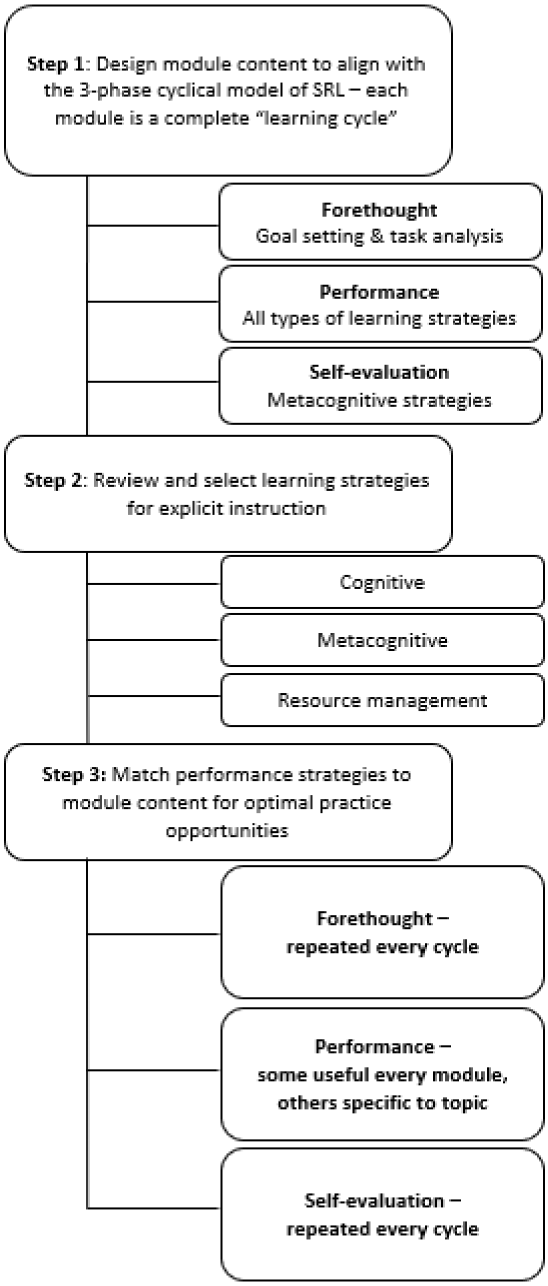

Figure 5-1: Development Process in the Design of the Current Intervention.

SRL= self-regulated learning

5.5.1. Step 1: Aligning Phases of the Self-Regulated Learning Cycle with the Content Modules

At this university at the time of implementation of the current intervention, the expectation for a unit of study was a total of 130 hours over a 13-week semester. This equated to 10 hours per week divided between instructional time and independent study. In the bioscience subject used for the current intervention, instructional time consisted of two hours of lectures scheduled in lecture rooms and two hours of practicals scheduled in laboratories. The initial iteration, in 2019, had one block of two hours for the lectures, while subsequent iterations had two blocks of one hour. Therefore, under these guidelines, the expectation was that students undertake a further six hours of independent study, in addition to the four hours of face-to-face contact with the instructor each week.

During the instructional time for each of the content modules, the three phases of Zimmerman's cyclical model were modelled by the instructor. At the completion of the self-evaluation phase for each module, students were instructed to undertake the three phases again during their independent study time to prepare for a low-stakes assessment task that concluded each module (more details on assessment below). Thus, across the course of the semester, the current intervention was designed to expose students to multiple self-regulatory cycles to raise students' perception of their value (Schunk & Ertmer, 2000).

Forethought. In the forethought phase of self-regulated learning, students perform a task analysis and set goals (Zimmerman, 2000a). This included selecting appropriate cognitive strategies for processing the information, appropriate metacognitive strategies for monitoring and maintaining their progress and appropriate resource management strategies, for example allocating the time available. Factors such as self-efficacy for learning the content, task value, and goal orientation can affect students' motivation to get started and to persevere when difficulties arise (Bandura, 1982, 1997). The goals set in the forethought phase were revisited again in the self-evaluation phase, where students made an assessment on whether the goals were met.

Therefore, when setting goals, students need to know what the criteria for success are, and what level of performance they want to achieve (Winne & Hadwin, 1998) so that they are able to gauge their progress. If students don't know or don't understand the criteria for success, it can be difficult for them to set realistic goals. In addition, smaller shorter-term goals are preferable to the global goal of 'passing the subject'. Furthermore, Schunk and Ertmer (2000) found that college students provided with specific *learning* goals rather than general *performance* goals (e.g., 'try your best') developed higher self-efficacy and were better at evaluating their learning progress. For this reason, learning outcomes were used as the criteria for success for each module. Therefore, the learning outcomes were given at the start of each module, and they were presented to students in terms of the types of understanding or level of thinking that was required for each one. The levels of thinking aligned with Bloom's Taxonomy of cognitive thinking (as modified by Anderson & Krathwohl, 2001) which is often used as a basis for writing learning outcomes (Adams, 2015; Cook et al., 2013; Newton et al., 2020; Zhao et al., 2014). As part of this curriculum design decision, students were given definitions for the common task verbs that would be used throughout the semester and explicitly shown how to undertake a task analysis.

As a further form of scaffolding of task analysis and goal setting, students were instructed to review the content provided in each module and attempt to relate it back to the learning outcomes. This strategy was included to assist students with identifying and extracting the main ideas of each module and monitoring their understanding.

Performance. During the performance phase of the learning cycle, students implement their plans and monitor their understanding (Zimmerman, 2000a). There is an element of monitoring during the performance phase; if students perceive that a learning strategy they have selected is not working, then they should adjust the strategy as they go. As such, the performance phase involves the use of different cognitive and metacognitive strategies to enable the student to interact with the material in a meaningful way for processing information for understanding and committing it to long-term memory and checking their comprehension as they progress. The literature on the study techniques of nursing students in bioscience suggests that they do not have a wide repertoire of skills on which they can draw for this phase (Andrew & Vialle, 1998; Barker et al., 2016; Felicilda-Reynaldo et al., 2017). Therefore, the current intervention was designed to help students to develop a repertoire of learning strategies that would be useful within the bioscience context.

During the instruction time, students were introduced to a range of learning strategies by explicit instruction embedded with the bioscience content. Between one and three strategies were included in each module, with explicit instruction on their declarative (*what* the strategy is), procedural (*how* the strategy is implemented) and conditional use (*when* the strategy is likely to work best). Instruction involved modelling by the instructor during the lectures and practicals, with opportunities for students to practice using the strategy under guidance, with bioscience content (Pressley et al., 1989; Sanders & Welk, 2005) (see full schedule in Table 5-4).

Self-Reflection – Self-Judgement and Self-Reaction. During the self-reflection phase of the self-regulated learning cycle, students reflect on their performance against the success criteria. At this time, they may make causal attributions, for example, "I worked really hard to succeed", "I am too dumb", "the lecturer is too disorganised" (Pintrich, 2000; Zimmerman, 2000a), and they may also give themselves rewards or punishments, for example, extra screentime, or reduced screentime (Bandura, 2001; Zimmerman, 2013).

The instruction time of each module ended with the practical session. At the end of this session, the module learning outcomes were revisited and students were prompted to give themselves a 4-point judgement of learning (see Figure 5-2) for each outcome (Butterfield & Metcalfe, 2001; Pintrich & Zusho, 2002), in preparation for planning their independent study. This process was undertaken to engage the students in regular self-evaluation against the success criteria of the learning outcomes of each module. Using this rating, students could now independently undertake the three phases of the learning cycle – planning, performing and self-evaluation – to develop personal short-term study goals and select learning strategies that they determine will assist them to prepare for the low stakes assessment task that completed each module (Figure 5-3).

These are the things that you should measure your success against. Use them to help you decide what to focus on this week.

Outcomes and materials covered	**Rating**
Describe the structure of an animal cell	
Link each organelle to its function	
Define homeostasis and ***explain*** its importance to normal human functioning	

Rate each outcome according to the following:
4 -- I know it well enough to make connections that weren't taught. I could teach it to a friend.
3 -- I know everything that was taught without making many mistakes
2 -- I know the easy parts, but I don't know the harder parts
1 -- I don't understand any of it, I need help.

Figure 5-2: Rating Tool for Student Self-Evaluation Against Learning Outcomes. (Further examples of resources are located in Appendix G)

Note. The learning outcomes for the module are listed. Additional space is provided for students to make links to other parts of the content covered.

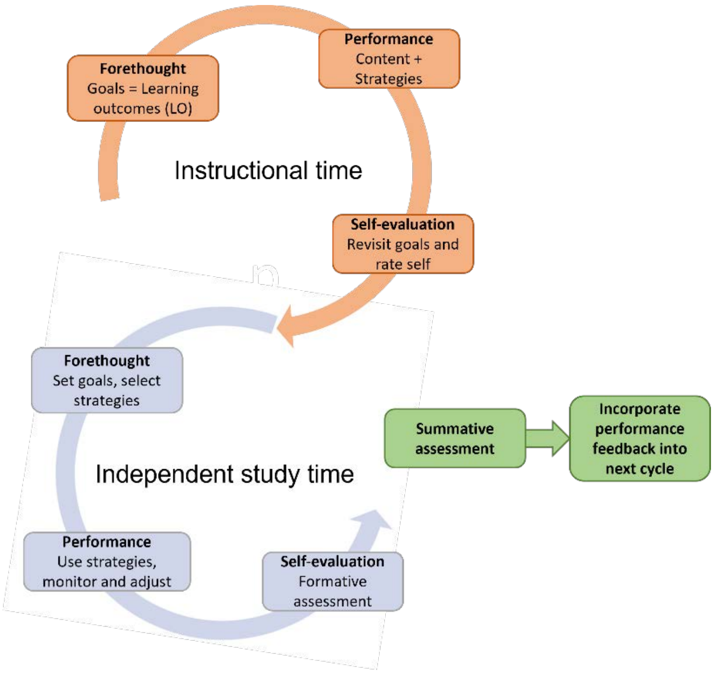

Figure 5-3: The Phases of the Cyclical Model During Instructional and Independent Study Time

5.5.2. Step 2: Informed Selection of Learning Strategies.

The 14 learning strategies identified by Zimmerman & Martinez Pons (1986) were used as a starting point for the identification and selection of cognitive, metacognitive and resource management skills required by self-regulated learners. These strategies are identified in Table 5-1, where they have been categorised into both the phases of learning cycle employed in the current intervention, and the strategy type as described by Weinstein et al. (2010). Weinstein's classification system has been included because it is widely recognised in the learning strategy literature and because it was used by Pintrich in his conceptual framework and in the development of the Motivated Strategies for Learning Questionnaire (Pintrich et al., 1991; Pintrich, 2000), which was used as a measure of change in a larger study involving the current intervention.

Table 5-1: The 14 Learning Strategies Used by High Achieving Students Classified into Phase of the Learning Cycle and Strategy Type

Zimmerman's Strategies[1]	Phase of Zimmerman's cycle[2]	Strategy type[3]
Goal setting and planning	Forethought	Metacognitive – self-regulation
Environmental structuring (principally avoiding distractions)	Forethought/ Performance	Metacognitive – self-regulation
Rehearsing and memorising	Performance	Cognitive – Rehearsal – superficial/passive
Review (notes, tests, textbook)[4]	Performance	Cognitive – Rehearsal – superficial/active
Organising and transforming	Performance	Cognitive – Organisation
Seeking information	Performance	Metacognitive – comprehension
Seeking help (peers, teacher, adults)[5]	Performance	Metacognitive – comprehension Resource management
Keeping records and monitoring	Performance	Metacognitive – comprehension
Reviewing tests	Self-reflection	Metacognitive – comprehension
Self-evaluation	Self-reflection	Metacognitive – comprehension
Self-consequences	Self-reflection	Metacognitive – self-regulation

Note. [1]Zimmerman & Martinez-Pons (1986); [2]Zimmerman (2000); [3]Weinstein et al. (2010); [4]grouping of strategies 12-14 as per Zimmerman & Martinez-Pons (1986, p. 681); [5]grouping of strategies 9-11 as per Zimmerman & Martinez-Pons (1986, p. 681)

Identification and Inclusion of Strategies A review of the literature on 'learning-to-learn' interventions was also undertaken to identify specific, empirically sound, cognitive, metacognitive and resource management strategies to include in the current intervention. For example, Zimmerman's strategy of "organising and transforming" (Table 5-1) is not a single strategy; rather, it can be divided into a number of cognitive strategies, such as concept mapping or constructing a flow chart. In addition, the review of the literature also aimed to identify empirically sound methods for teaching the identified strategies. The following section details the strategies that were included in the current intervention and some of the approaches that were undertaken to embed those strategies into the curriculum of the subject.

Cognitive learning strategies are mental processes used to learn, understand, and commit to memory content that will help students to reach their academic goals. Weinstein and Meyer (1991) note that cognitive learning strategies are goal directed, intentionally invoked, effortful and situation specific – intrinsic factors such as the subject, task or context will impact the usefulness of a particular cognitive learning strategy, as will extrinsic factors such as time available and competing priorities.

Weinstein and Mayer's (1983) early work separated cognitive learning strategies into three categories: rehearsal, elaboration and organisation (see Table 5-2). Rehearsal strategies are often conceptualised as surface level learning techniques that are used to rote learn or memorise information. However, there is "an important distinction between memorising without understanding first [rote learning] … and memorisation when you have understood [meaningful memorisation]" (Marton, Wen & Wong (2005) in Hattie & Donoghue, 2016, p. 10), and therefore, rehearsal learning strategies are not inherently undesirable for student learning. An early model by Shuell (1990) suggested that different learning strategies become more and less important and effective at different points on a student's learning journey particularly when learning a complex body of knowledge. This suggestion has since been reiterated by Hattie and Donoghue (2016) following a synthesis of 228 meta-analyses investigating learning strategies. Furthermore, Hattie and Donoghue (2016) suggest that strategies such as summarising, note-taking and mnemonics are effective in the initial stages of acquiring new knowledge, followed by review, deliberate practice and repetition. Once students have some 'surface' understanding, then elaboration and organisation strategies become more effective to identify relationships between ideas and concepts and help students progress to 'deeper' understanding. Accordingly, strategies from all cognitive categories have been included in the current intervention.

Application of Cognitive Strategies in the Intervention. The current intervention study occurred in a foundation level biosciences subject; therefore, most of the students had limited exposure to the discipline specific vocabulary used during teaching and learning activities. For this reason, the first rehearsal strategy recommended to students was the use of flashcards for the internalisation of vocabulary (Hattie & Donoghue, 2016; Weinstein et al., 2010). In addition, a list of essential glossary terms was given for each module. Students were shown how to use the flashcard application (app) Quizlet (www.quizlet.com) to make and use sets of flashcards, with links to example sets. Alternative apps and offline flashcards were also discussed.

Elaboration and organisation strategies are deep-level strategies that require greater cognitive work than rehearsal strategies and provide more meaningful understanding of the concepts. The main aim of elaboration strategies is to make connections between new information and prior knowledge. Weinstein et al. (2010) note that this is the most diverse category of learning strategies and indicate that it is the active processing of the information rather than the specific strategy that is important. Several elaboration strategies were introduced to students in the current intervention (details below Table 5-4). For example, students were instructed on how to make their own analogies but were also more generally instructed to try to make connections within and between content - this cognitive process of linking concepts was also modelled by the instructor. A second elaborative learning strategy that was explicitly taught and practiced was comparing and contrasting similar and different concepts to find the nuance between them. The ability to identify patterns as well as similarities and differences are advanced skills and are important for applying learning to new situations (Hattie & Donoghue, 2016).

Organisation strategies aim to transform information into a form that makes it easier to understand and remember. Weinstein et al. (2010) note that the benefit of organisation strategies comes from both the active processing of information and the product that is created, which can be used for future revision. Examples of organisation strategies included in the current intervention are concept mapping, summary tables and flow charts.

In addition to the above classifications of cognitive strategies, Schraw et al. (2006) include problem solving and critical thinking as cognitive strategies. However, they describe a metacognitive element to critical thinking by stating that students must reflect on whether new information is consistent with their prior knowledge and draw conclusions (Schraw et al., 2006, p. 113). Critical thinking is also a component of Pintrich's self-regulated learning conceptual framework (2004). In a bioscience context, Michael (2007) notes that critical thinking is a crucial skill in applying physiological concepts, and in the literature concerning the 'bioscience problem' with nursing students there is often concern about the application of bioscience knowledge in the clinical context (Bakon et al., 2016).

Therefore, activities to strengthen critical thinking skills were also included in the current intervention. Halpern (1998) provides a framework for teaching in a way that will increase general critical thinking skills. Halpern discusses seven general skills that students should develop to become better at evaluating information critically. Instructor modelling and opportunities to practice four of those general skills were incorporated. These were: understanding how cause is determined (cause and effect thinking), giving reasons to support a conclusion (justifying answers), incorporating isolated data into a wider framework (making connections between concepts) and using analogies to solve problems.

In addition, student-centred teaching methods were used to encourage students to process the material actively and co-construct meaning. Student-centred learning is often equated with active learning (Thalluri & Penman, 2020). Therefore, the lecture portion of the instructional time was composed of didactic teaching of key information with active learning activities such as clicker questions (Anderson et al., 2023; Yang et al., 2023) and small group work interspersed throughout, in a manner similar to the live portion of the “lectorial” described by Thalluri and Penman (2020).

Table 5-2: Taxonomy of Learning Strategies

	Category	Examples	Useful for
Cognitive	Rehearsal	Flash cards, mnemonics (passive - repetition)	Discrete information, e.g., vocabulary, names of things (anatomy)
		(active – additional opportunities for further processing) highlighting information then reviewing again	
	Elaboration – actively processing	Basic – paraphrasing and summarising – putting into own words is cognitive work More complex – analogies, compare-contrast	Connecting to prior knowledge
	Organisation – translating or transforming information into a new configuration	Outlines, concept maps, concept matrices (tables), flow charts (organising into categories, hierarchies or sequences)	Making connections between concepts Looking for trends (reduce the amount of material to learn)
Metacognitive	Metacognitive Self-Regulation	Goal setting, planning, implementing, monitoring, evaluating	Fine tune strategic approaches – manage cognitive, motivation, emotional and environmental factors
	Metacognition – comprehension monitoring	Self-testing	Comprehension monitoring

Note. Adapted from "Learning and cognition – issues, concepts, types – focus on learning" by C.E. Wiensten, J. Jung and T.W. Acee, 2010, *International Encyclopedia of Education,* 323-329 (http://doi.org/10.1016/B978-0-08-044894-7.00497-8)

Application of Metacognitive Learning Strategies. Schraw et al. (2006) describe metacognition as a hierarchy consisting of two subcomponents: knowledge of cognition and regulation of cognition. Knowledge of cognition relates to the students' knowledge of the repertoire of cognitive strategies available to them, and also of their own strengths and weakness as learners. Knowledge of cognition is further broken down into declarative knowledge (*what*), procedural knowledge (*how*) and conditional knowledge (*when*). Students need to practice a variety of learning strategies in a range of situations before they have sufficient knowledge of cognition to successfully regulate cognition (Schraw et al., 2006; Schunk, 1993; Weinstein & Meyer, 1991).

Regulation of cognition, on the other hand, involves planning, monitoring and evaluating the learning (Schraw et al., 2006) and correlates with the skills and strategies of the self-regulated learning models of Pintrich and Zimmerman, and is applicable to all phases of the learning cycle. While the forethought phase is particularly important for planning, and the self-reflection phase is particularly important for evaluating, the performance phase also requires monitoring of the use and utility of the selected learning strategies as they are being used, and of the level of comprehension of the material to be learned.

In adults, the processes of self-regulation may not always be conscious because they may have become automated and may have developed without conscious effort (Schraw et al., 2006). Therefore, some students may not be aware of them, or able to express them when asked. The main educational strategy used to make metacognitive monitoring explicit during the current intervention was instructor modelling of the processes during the forethought and self-reflection phases of the learning cycle (Pintrich, 1995; Sanders & Welk, 2005).

During the forethought phase, modelling consisted of the presentation of the learning outcomes along with a task analysis unpacking each learning outcome in accordance with Bloom's taxonomy of thinking (Anderson & Krathwohl, 2001). During the self-reflection phase at the end of each practical session, there was discussion about the skills and knowledge covered during the module. Students were encouraged to rate their current level of understanding of each of the learning outcomes.

5.6. Intervention Details

5.6.1. Context and Settings

The context for the current intervention is an Australian Qualifications Framework level 5 (AQF5) bioscience subject. This subject is core to the Diploma of Higher Education – Health Major, which is an alternate pathway to bachelor's studies at a regional Australian university. The Diploma was open access, with no entry requirements. The current intervention was delivered as an integrated component of the content, and therefore, no incentives were provided for student participation.

5.6.2. Participants

The students were a mix of school leavers and those seeking a change of career. Most students in the Health Major of the Diploma were aiming for admission to one of the health programs offered by the university; these include: nursing, midwifery, occupational therapy, sports and exercise science, speech therapy, physiotherapy, biomedical science, medical laboratory science, pharmacy and veterinary science. In 2019, the first iteration of the current intervention was delivered to all students on the main campus, while students on the second campus were given the content only with no intervention. There was a total of 97 students enrolled at the main campus at the end of the semester. Since 2020, the intervention has been delivered to all students on both campuses and an additional external offering of the subject.

5.6.3. Ethics Approval

Ethics approval was granted by a regional university Human Ethics Committee (approval number H7611) in accordance with the National Statement of Ethical Conduct in Human Research.

5.6.4. Content of the Foundation Bioscience Subject

The content of the subject was developed to provide the background content knowledge and experience needed to prepare students for the topics covered in the first-year anatomy and physiology subjects of the health bachelor’s programs available at the university, thereby providing theoretical preparation for future subjects. There were ten modules delivered over a thirteen-week semester (Table 5-3).

Table 5-3: The Bioscience Content Included in the Foundation Subject

Module	Title	Main Content
1	Introduction to the human body	anatomical terminology, body systems overview
2	Cells and homeostasis	levels of organisation, cells, homeostasis
3	Basic elements of life	atoms, elements, ions, compounds and bonding
4	Water biology	properties of water, pH, buffers
5	The cell membrane	transport across the membrane, tonicity
6	The genetics of life	nucleic acids, protein synthesis
7	The essential compounds of life	macromolecules
8	The essential reactions of life	enzymes, ATP production (basic)
9	Why we beat, breathe and eat	body systems: cardiovascular, respiratory, digestive
10	Communication in the body	body systems: endocrine, nervous

5.6.5. Content Assessment

For the first eight modules, the students undertook a low-stakes summative assessment quiz at the end of the module, consisting of multiple-choice questions (MCQ). Due to the potential of lower-order thinking MCQs encouraging surface learning (Sand-Jecklin, 2007; Snelgrove, 2004), a concerted effort was made to write higher-order level questions, requiring Bloom's levels of analyse and apply (Anderson & Krathwohl, 2001). The quizzes were worth 5% each for a total of 40% of the final grade. A number of formative assessment quizzes were available to assist students to prepare for the summative quizzes, by using retrieval practice as a study technique (Ariel & Karpicke, 2018; Dunlosky et al., 2013). The formative quizzes also provided additional opportunities for students to self-evaluate. The scaffolding of the summative assessment was removed for the final two modules, which were the main focus of the end of semester examination, which was worth 20%. The final two modules draw the background knowledge taught in earlier modules together and present it in the context of several of the body systems. The remainder of the assessment for the subject consisted of a group presentation worth 30% and 10% for the practical workbook; these assessment items are not directly relevant to the current intervention. The assessment schedule has undergone some adjustments since the first iteration of the intervention in 2019.

5.6.6. Instructor

The author was the sole instructor for the intervention. The instructor has bachelor's degrees in biological sciences and teaching and is completing a PhD in educational psychology focussed on self-regulated learning. This instructor had 5 years prior experience in teaching biosciences to a range of nursing, allied health, and veterinary students, followed by a further 5 years of teaching secondary science subjects, before developing the current intervention.

5.6.7. Intervention Learning Outcomes

Students were provided with the following learning outcomes focussed on the learning strategy portion of the curriculum:

By the end of this subject, you should be able to:

- Set learning goals
- Identify appropriate learning strategies
- Monitor and evaluate your progress
- Adapt learning strategies when required.

However, there was no assessment task to specifically measure the attainment of these goals.

5.6.8. Schedule

The metacognitive and cognitive learning strategies explicitly taught to the students are shown in Table 5-4. The timing of each of the skills is related to the content topics and the opportunities for practicing the skills during the practical.

Table 5-4: Timing of Learning Strategies Taught During the Semester

Strategy	Category	Student Practice
Task analysis – Learning outcomes	Forethought and self-reflection Metacognitive	Every module
Pre-reading strategy – Priming	Forethought Metacognitive	Every module
Know your verbs (Bloom's Levels of Thinking) – task analysis	Metacognitive	Every module
The learning cycle	Metacognitive	Module 2
Flashcards	Cognitive - Rehearsal	Module 1 Every module
Concept mapping	Cognitive - Organisation Critical thinking	Module 1 Module 7
Mnemonics and analogies	Cognitive - Elaboration	Module 2
Chunking	Cognitive - Organisation	Module 2
Peer learning	Cognitive – Peer learning	Module 3 Every module - practical session
Help seeking	Metacognitive	Module 3 - jigsaw activity Every module practical session
Time management	Resource management (time)	Module 4
Goal setting (for studying)	Forethought	
Compare and contrast	Cognitive – Elaboration/ Organisation	Module 4 Module 5 Module 6 Module 12
Extracting information from lectures	Cognitive - Organisation	Module 5 Module 7 Module 10
Flow diagrams	Cognitive - Organisation	Module 2 Module 6 Module 10
Self-evaluation with self-testing	Metacognitive	Module 6 Every module – formative assessments
Growth mindset Self-efficacy	Motivation	Module 8 – factors that can affect motivation
Cause and effect thinking	Cognitive - Critical thinking	Module 10

5.7. Evaluation of the Intervention

The following chapters of this thesis undertake quantitative and qualitative evaluation of this intervention. Quantitative evaluation was undertaken using the Motivated Strategies for Learning Questionnaire (MSLQ) in 2019. The MSLQ was given at the beginning and end of the semester-long intervention. Matched questionnaires were compared to look for changes in motivation or reported use of learning strategies. The MSLQ scores were also matched with the final mark of the participant to uncover any correlation between the two. The quantitative investigation is described in Chapter 6.

In addition, participants of the intervention were invited to semi-structured interviews to share their learning strategy use in the lead up to the final examination for the subject. Qualitative analysis of the transcripts is described in Chapter 7

6. Chapter 6: Effect of an Integrated Self-Regulated Learning Intervention in a Foundation Bioscience Subject: A Quantitative Research Study.

6.1. Abstract

Background: Providing commencing university students with support to improve their use of learning strategies and increase their self-efficacy for learning biosciences have been recommended as measures for improving achievement and retention of nursing students (McVicar et al., 2014). An intervention providing explicit instruction in the processes and learning strategies associated with self-regulated learning theory was implemented within a bioscience subject. The Motivated Strategies for Learning Questionnaire (MSLQ) was used to measure motivation and strategy use before and after the intervention.

Research question: Are there changes in motivations and learning strategy use following an integrated self-regulated learning strategy intervention?

Design: Quasi-experimental study of an educational intervention using a pre-test and post-test design with a convenience sample.

Settings: An Australian regional university.

Participants: Pre-bachelor program students enrolled in a foundation bioscience subject.

Methods: A self-regulated learning intervention was carried out during a one semester bioscience subject. The Motivated Strategies for Learning Questionnaire (MSLQ) was distributed at the beginning and end of the semester.

Results: There were 36 participants who completed the MSLQ at the start and the end of the semester. There were weak effect sizes for an increase in critical thinking (d=0.332) and a decrease in time and environment management (d=0.326) by the end of the semester; however, these did not reach statistical significance. There was a positive correlation between overall academic achievement in the subject and self-efficacy at the beginning of the intervention, which was stronger at the end of the intervention. The highest achieving students reported the highest scores on both motivation and learning strategy use subscales.

Conclusions: By the end of the semester, there was a low-to-medium effect size in these students for an increase in critical thinking, which may be due to the impact of the intervention that was designed to promote the use of self-regulated learning strategies. However, most strategies measured by the MSLQ did not show a statistically significant improvement within one semester, although changes were trending in the preferred direction. The small sample size may have impacted the ability to

detect anything less than a medium effect size and a larger student population may be able to detect changes of statistical significance.

6.2. Background

There is considerable literature noting the difficulty that nursing students have with bioscience subjects such as anatomy and physiology and pathophysiology, in the early years of their bachelor's programs (Caon & Treagust, 1993; Jensen et al., 2018; McVicar et al., 2015). Nursing students are not alone in experiencing bioscience subjects as difficult. More recently, discipline-based education researchers have investigated students across other health-related disciplines such as pharmacy, speech pathology and biomedicine, as these students also find some challenges with learning foundation bioscience theory (Colthorpe et al., 2018; Michael, 2007; Slominski et al., 2019; Sturges & Maurer, 2013). However, nursing students often have not completed secondary science, as it is rarely a pre-requisite for entry to nursing programs, and they may have low self-efficacy for science in general (Andrew et al., 2015; Andrew & Vialle, 1998; Caon & Treagust, 1993; Crane & Cox, 2013).

For Registered Nurses (RNs), the early subjects in bioscience provide fundamental information on which they will base their clinical decision making (Birks et al., 2018; McVicar et al., 2014, 2015; Prowse & Lyne, 2000). In a survey of RNs' perceptions of importance of science knowledge to their clinical practice, RNs gave the highest priority to anatomy, physiology and pathophysiology topics (Birks et al., 2018). Other studies report similar findings about RNs' perceptions of the importance of making connections between their bioscience knowledge and their clinical practice (Craft et al., 2017; Montayre et al., 2021)

Furthermore, "suboptimal bioscience knowledge of registered nurses has been consistently correlated with avoidable morbidity and mortality" (Aiken, 2003; Aiken et al., 2014; Blegen et al., 2013; Perkins, 2019, p. 7). It has been reported that undergraduate nursing students and RNs struggle to apply their bioscience knowledge to clinical practice (Bakon et al., 2016; Mckee, 2002; Smales, 2010), and McVicar et al. (2015, p. 504) suggest that the struggle to apply knowledge may be due to "a failure of some students to grasp the fundamentals of human bioscience". When interviewed about their experiences in applying bioscience knowledge in the clinical setting, recently graduated RNs felt that the evidence-base gave them greater confidence in their decision making and improved their relationship with patients and families (Montayre et al., 2021).

Biosciences are content-heavy subjects. Nursing students report spending more time on these subjects than on other subjects (Craft et al., 2013; Gordon et al., 2017). When embarking on learning a new complex body of knowledge, students often over-rely on surface learning strategies to memorise seemingly unrelated facts (Shuell, 1990). It has been reported that nursing students tend to be more reliant on surface learning strategies within the biosciences (Bengtsson & Ohlsson, 2010; Craft et al., 2013; Crane & Cox, 2013; Salamonson et al., 2013). Therefore, students may need additional support to assist them in moving to deeper levels of information processing and critical thinking to enable them to gain deeper understanding and therefore, be able to apply their bioscience knowledge in clinical practice.

Following a major review of Year 1 nursing programs, McVicar et al. (2015) concluded that the literature showed inconsistent correlations between achievement in the biosciences and many of the commonly investigated factors, such as admissions scores and experience in secondary science, and no correlation between most demographic factors such as gender, ethnicity and personality type. McVicar et al. (2014) also reported on interventions within year 1 programs, and recommended that time should be spent early in the program to develop students' study skills along with their self-efficacy for learning biosciences.

Based on these findings and the recommendations from McVicar et al. (2014), a learning intervention that was based on the theoretical framework of self-regulated learning was implemented within a foundation biosciences subject that was part of a diploma-level pathway towards gaining entry to bachelor's degrees at university for nursing and allied health students. The Motivated Strategies for Learning Questionnaire (MSLQ) was used as the measurement instrument (Pintrich et al., 1991), in a pre-test and post-test design. The MSLQ has subscales covering students' motivations towards studying including self-efficacy, task value and goal orientation, and also covering cognitive, metacognitive and resource learning strategies that they may employ to reach their learning goals.

The research questions for this investigation were:

1. How do students' scores on the MSLQ change after one semester of self-regulated learning training that was embedded within a bioscience subject?
2. How are students' scores on the MSLQ correlated to their achievement in bioscience?

Further, it was hypothesised that self-regulated learning training will improve students' scores on many of the MSLQ subscales, in particular self-efficacy, metacognitive self-regulation, and critical thinking. All of the cognitive strategies are relevant to learning at the introductory level (Hattie & Donoghue, 2016; Shuell, 1990); therefore, it was hypothesised that the reported use of rehearsal (surface), elaboration and organisation strategies will all be high, although the use of the deeper strategies should be higher at the end of the semester.

6.3. Method

The current study used an observational pre-post design. The pre-semester survey was opened to students for one week, beginning in the lecture on 9th August 2019, which was the end of week 2. Participants were recruited via a verbal notice during the lecture, given by a supervisor not associated with teaching the students. The researcher involved with teaching the cohort was not present at the time. In addition, a written notice was posted on the learning management system for this subject. The post-semester survey was opened to students for the final two weeks of a 13-week semester from 18 October 2019.

6.3.1. Participants and Settings

The setting for this intervention was a regional Australian University. This intervention was designed based on the approach of an integrated meta-curriculum (Weinstein, 1982) in a foundation bioscience subject called Introduction to Health Sciences. The subject was part of a Diploma Pathways program, which is an alternate pathway to university for students who do not meet the entry requirements for a bachelor's degree. It was a core subject for students undertaking the Health Major. The content of the subject was designed to provide a strong foundation in concepts required for first year anatomy and physiology subjects in the nursing and allied health programs of the university.

A total of 64 of the 86 diploma students enrolled in the subject at one campus completed the pre-intervention questionnaire, and a total of 41 students completed the post-intervention questionnaire. There were 36 students who completed both the pre- and post-intervention questionnaires (41.9% response rate), and these formed the study population, as they allowed direct comparison of individual students pre- and post-intervention responses.

6.3.2. Instrument and Data Collection

The Motivated Strategies for Learning Questionnaire (MSLQ) contains 81 items in 15 subscales (Pintrich et al., 1991). The questionnaire consists of two parts: factors shown to influence student motivation, and learning strategies shown to have a positive association with student achievement. The motivation part of the questionnaire measures student values and expectancies regarding learning, and includes the following subscales: intrinsic goal orientation, extrinsic goal orientation, self-efficacy, control of learning beliefs, task value and test anxiety. The learning strategy part includes cognitive, metacognitive and resource management strategies and includes rehearsal, elaboration, organisation, critical thinking, peer learning, metacognitive self-regulation, effort regulation, time and environment management and help seeking. All items are rated on a 7-point Likert-type scale, with 1 being "not at all true of me" and 7 being "very true of me". The scale was developed over a number of years by Pintrich and colleagues (Duncan & Mckeachie, 2005; Pintrich et al., 1993) and was used by those authors with college students.

In providing interpretation of the scores, Pintrich et al. (1991) state that a higher score is better than a lower one (except for the test anxiety subscale), and they consider less than or equal to 3 to be a low score. In the current study, Pintrich et al.'s "higher" category was further divided into moderate (4) and high (5, 6 or 7).

Demographic information was collected at the beginning of the questionnaire including age, gender, and whether the student was the first in family to attend university status, had previous experience in a higher education setting, had completed secondary education and obtained an ATAR (Australian Tertiary Admissions Rank for admission to university), and whether they had completed any senior science subject, as well as their study load. Students were also asked to estimate how much time they planned to spend studying for this subject, and how much time they would spend in paid employment, each week.

In addition, students were asked to indicate the degree program (future field of study) they were aiming to enter in the year following their Diploma. Finally, the grades achieved by the students were included at the end of the semester. Students who achieved a grade of HD or D were considered to be higher achieving, while those who achieved a P or N were considered to be lower achieving.

6.3.3. Intervention

The intervention embedded the explicit teaching of self-regulated learning strategies within the content of the subject. A range of empirically-supported cognitive, metacognitive and resource management strategies were selected to be delivered within a learning cycle, based on the cyclical model of self-regulation described by Zimmerman (most recent version in Zimmerman & Moylan, 2009).

The intervention aimed to:

- increase self-efficacy for learning bioscience content
    - by increasing the repertoire of learning strategies that students have available for learning, understanding and processing the content
    - through mastery experiences with bioscience content by utilising these learning strategies
- increase the use of critical thinking skills within the biosciences
- increase students' metacognitive regulation of their learning

Each module of content was delivered as a complete "learning cycle". A learning cycle included all three phases of Zimmerman's model (Zimmerman & Moylan, 2009). Thus, there was a *forethought phase* that consisted of defining goals (learning outcomes) and planning, which was followed by a *performance phase* where instruction and practice occurred. Finally, there was an *evaluation phase*, where students completed formative and summative activities, which gave students information to feed back into the cycle.

Nested within the phases, was the explicit instruction of various learning strategies. One to three cognitive, metacognitive and resource management learning strategies were matched with appropriate content of each of 10 week-long modules. Matching of relevant strategies with content enabled students to practice the strategies during practical sessions in context, with the subject material. For example, concept mapping is a cognitive learning strategy that is useful for organising information and promoting critical thinking (Breytenbach et al., 2017; Lee et al., 2013); this strategy was taught in module 1 and practiced again in several subsequent modules. Additionally, task analysis and self-evaluation are metacognitive strategies that were practiced in every module. Instruction of the learning strategies was embedded within the content, rather than being taught separately, to promote the seamless integration of learning strategies with the content. Therefore, the entire student cohort was exposed to the intervention through the normal course of the semester learning. Students were informed at the start of the semester that learning strategies were being embedded, after which the information was presented as though it was a normal part of the content.

6.3.4. Data Analysis

Data were analysed using SPSS Version 28. Shapiro-Wilks' test of normality was carried out for each MSLQ subscale. Where data conformed to normal distribution, a two-sided paired t-test was used to compare the pre- and post-intervention results, as responses from the pre- and post-intervention MSLQ were matched for each participant. Where data was non-normally distributed, a Wilcoxon-signed rank test was used. Effect size was calculated using Cohen's d and is reported in addition to statistical significance (p value). Analysis of the effects of demographic factors on grades and on the scores on the MSLQ were carried out using non-parametric Kruskal-Wallis tests. Questionnaires with missing data were excluded from analysis of subscales where data was missing, but included in subscales where all items were answered.

Internal consistency of the MSLQ subscales with this cohort was measured using Cronbach's alpha and values were consistent with the original description of the instrument (Pintrich et al., 1991 see Appendix D). Pearson's correlations were performed to investigate any correlations between final grade and the MSLQ subscales at both time points. Graphs were produced using R-Studio and ggplot2 version 3.4.3. Power analysis was undertaken using G*Power 3 (Faul et al., 2007).

6.3.5. Ethics Approval

This study was part of a larger study that was granted Human Ethics approval by the University Human Research Ethics Committee (approval number H7611). Full information outlining the investigation and noting that data would be matched between MSLQ questionnaires and with student's final grade, was provided to students to allow them to make an informed decision regarding consent to participate. Only students who consented progressed to the next page of the online questionnaire.

6.4. Results

6.4.1. Demographics

The demographics of the 36 students in the study population are summarised in Table 6-1. Just over half of the participants were school-leavers (52.8%), two thirds were female (69.4%) and 55.6% were the first in their family to attend university. Most students had completed the final year of secondary education (86.1%). However, not all of those had intended to attend university, as they did not study for an ATAR (33.3%). Just under half of students (44.4%) had not studied either biology or chemistry at senior secondary level. Students were not asked to provide their ATAR result. However, university data shows that students enrolled in this subject represented the full range of ATAR possible. Almost half of the whole cohort (44.7%) did not have an ATAR, 12.1% achieved an ATAR between 51-60 and 5.7% of students were in the range 91-100, with 20.6% of students achieving between 61 and 90. Thus there was a very wide range of academic entry scores within this subject.

Most students undertaking the diploma program use it as an entry pathway to a bachelor's degree. Therefore, students were asked to indicate which program they intended to pursue following the diploma. The largest proportion of participants indicated that they would be enrolling in a nursing program (36.1%), and 11.1% of participants were undecided. The remainder of the participants were spread across the other allied health programs offered by the university (see Table 6-1). Overall, most of the participants passed the subject (>90%) and the pass rate for the entire cohort was 84%.

None of the demographic factors had statistically significant relationship with overall grades in this subject. However, since there were small numbers of each of the potential future field of study, these were grouped into those who were likely to enrol in the Bachelor of Nursing Science (“nursing-likely”) and “other”. The difference in the grade achievement of these two groups approached significance (H= 3.773, p=0.052, df=1). “Nursing-likely” students achieved a lower mean final mark of 60.73% (±10.075), while “others” achieved 71.87% (±12.620).

Table 6-1: Demographics and End-of-Semester Results of the Participants

Demographic	Category	Count (%) n=36
Age	19 and under	19 (52.8)
	20-24	11 (30.6)
	25-29	4 (11.1)
	30+	2 (5.2)
Gender	Male	11 (30.6)
	Female	25 (69.4)
First in Family	Yes	16 (44.4)
	No	20 (55.6)
Matriculation	With ATAR	19 (52.8)
	Without ATAR	12 (33.3)
	N	5 (13.9)
High School Science	Biology	10 (27.8)
	Chemistry	3 (8.3)
	Biology and Chemistry	6 (16.7)
	Neither Biology nor Chemistry	16 (44.4)
	Did not answer	1 (2.8)
Previous Higher Education Study	Yes	11 (30.6)
	No	25 (69.4)
Study Load	2 subjects	3 (8.3)
	3 subjects	18 (50.0)
	4 subjects (full-time)	15 (41.7)
Potential future field of study	Nursing	13 (36.1)
	Occupational Therapy	6 (16.7)
	Pharmacy	5 (13.9)
	Biomedical Science	4 (11.1)
	Physiotherapy	2 (5.6)
	Psychology	1 (2.8)
	Other	1 (2.8)
	Undecided	4 (11.1)
Final Grade	HD: >85%	3 (8.3)
	D: >75% and <85%	8 (22.2)
	C: >65% and <75%	8 (22.2)
	P: >50% and <65%	15 (41.7)
	N: <50%	2 (5.6)

Note. ATAR = Australian Tertiary Admissions Rank; HD = High Distinction, D = Distinction, C = Credit, P = Pass, N = Not satisfactory

Four students reported an excessive amount of study at the end of the semester (>10 hours per week) reporting times ranging from 12 hours to 30 hours per week (Table 6-2). These students achieved 2 passing grades, a credit and a distinction. With those outliers removed the mean study times did not differ significantly between the achievement levels (F=0.033, p=0.998, df=4); however, the median was much lower for the distinction level students (Figure 6-1). Similarly, number of hours of employment did not have a significant effect on grade achieved (Table 6-2; F=0.702, p=0.598, df=4). The 13 students that reported that they did not undertake paid employment received almost the full range of grade levels: 7 students achieved a passing grade, 4 students achieved a distinction and 1 student each achieved a credit and a not satisfactory. There was a slight decrease in the number of hours of study reported in the post-intervention questionnaire at the end of the semester, compared with the start of semester, but this was not statistically significant.

Table 6-2: Hours of Independent Study and Paid Employment of the Participants

	Pre-intervention Count (%)	Post-intervention Count (%)
Study Hours		
<4	2 (5.6)	8 (22.2)
4-6	12 (33.3)	13 (36.1)
7-10	16 (44.4)	11 (30.5)
>10	6 (16.7)	4 (11.1)
Employment hours		
0	9 (25)	13 (36.1)
1-9	4 (11.1)	3 (8.3)
10-19	7 (19.4)	3 (8.3)
20-29	11 (30.5)	10 (27.8)
>=30	5 (13.9)	7 (19.4)

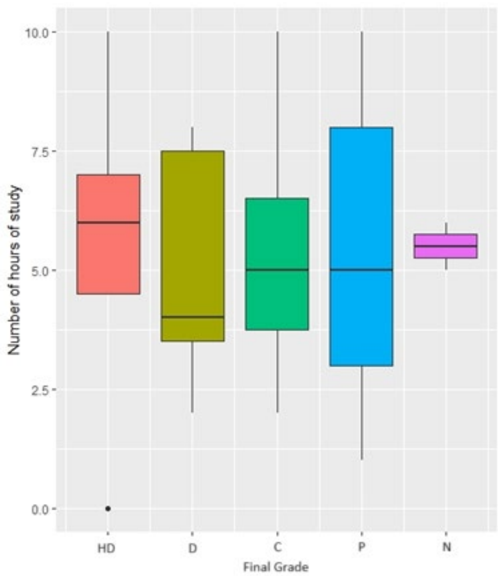

Figure 6-1: Reported Number of Study Hours by Students at Different Levels of Achievement

6.4.2. Comparison of Pre- and Post-Intervention Motivated Strategies for Learning Questionnaire Scores

None of the MSLQ subscales showed a statistically significant change from pre-intervention to post-intervention. However, two subscales had an effect size over 0.3 (weak effect; Cohen, 1988). These were an increase in critical thinking (d=0.332) and a decrease in time and environment management (d=0.326; Table 6-3). Before the intervention, students' reported use of critical thinking strategies scored 3.9 (±1.14) and following the intervention this had risen to 4.3 (±1.25; p=0.077). A-prior power analysis suggested that a sample size of 34 would be sufficient to detect a moderate effect size (0.5), but that weak effect size (0.3) would require a sample size of 90 participants. Therefore, the sample size may have been too small to detect changes weak.

Table 6-3: Measures of Self-Regulated Learning of Diploma Students, Pre- and Post-Intervention

		Pre		Post		Trend	P-value	Cohen's d[3]
MSLQ	Subscale	Mean	SD	Mean	SD			
Motivation	Intrinsic	5.0	1.02	5.0	1.13	→	0.751	0.000
	Extrinsic	5.3	1.20	5.1	1.48	↓	0.240	0.148
	Task Value[1]	5.9	0.95	5.9	1.16	→	0.973	0.000
	Control of Learning Beliefs[1]	5.7	0.89	5.8	1.04	↑	0.239	0.103
	Self-Efficacy for Learning	4.7	1.00	4.8	1.35	↑	0.465	0.084
	Test Anxiety	4.8	1.49	4.7	1.71	↓	0.684	0.062
Cognitive strategies	Rehearsal	4.9	1.33	4.7	1.37	↓	0.268	0.148
	Elaboration[2]	4.6	1.09	4.8	1.06	↑	0.355	0.186
	Organisation	4.8	1.18	4.6	1.32	↓	0.181	0.160
	Peer Learning	3.8	1.53	3.9	1.46	↑	0.741	0.067
	Critical Thinking	3.9	1.14	4.3	1.25	↑	0.077	0.332
Metacognitive strategies	Metacognitive Self-regulation[2]	5.0	1.00	4.9	0.71	↓	0.821	0.115
	Effort Regulation[1]	5.3	1.21	5.0	1.32	↓	0.158	0.237
Resource Management	Environment[2]	5.1	0.87	4.8	0.97	↓	0.226	0.326
	Help seeking	3.9	1.38	3.8	1.37	↓	0.866	0.073

Note. MSLQ Scale: 1= not at all true of me to 7= very true of me. [1]Wilcoxson Signed Rank, all other analysis used two-sided paired t-test. [2]number of participants was 19 for 3 subscales due to missing values, all other subscales n=36. [3]Effect sizes: <0.3 = negligible 0.3-0.5 = weak, 0.5-0.7 = moderate, 0.7-0.9= strong

Conversely, time and environment management decreased over the semester. At the start of the semester the average score was 5.1 (±0.87), while at the end of semester it had decreased to 4.8 (±0.97).

Motivation. Extrinsic and intrinsic goal orientations were both high, with intrinsic goal orientation remaining at 5.0 (±1.02 pre-; ±1.13 post-intervention; Table 6-3) over the semester and extrinsic goal orientation decreasing slightly from 5.3 (±1.20) to 5.1 (±1.48). Task value scores and control of learning beliefs were also high at 5.9 (±0.95 pre-; ±1.16 post-intervention) and 5.7 (±0.89 pre-) and 5.8 (±1.04 post-intervention), respectively. Test anxiety remained at a moderate level over the semester, as did perceived self-efficacy for learning the biosciences.

Cognitive Strategies. Students reported a moderate to high use of rehearsal, elaboration and organisation strategies, which did not change significantly over the semester. The use of peer learning and critical thinking were not strongly reported at the start of semester. Peer learning remained low at the end of semester (3.9 ± 1.46 post). However, critical thinking increased (4.3 ± 1.25).

Metacognitive Strategies and Resource Management. The reported use of metacognitive self-regulation and effort regulation strategies were both high at the beginning of semester 4.9 (±0.71) and 5.0 (±1.32) respectively. Both scales decreased non-significantly over the semester. Students' reported use of human resources such as instructors via help seeking strategies, was low to moderate (3.8 ±1.41), which was comparable to their use of peer learning strategies.

6.4.3. Achievement

Self-efficacy had a statistically significant weak positive correlation with achievement in the pre-intervention responses (r=0.360, p=0.031), which increased to a moderate correlation in the post-intervention (r=0.535, p=0.001) survey. While not statistically significant, there was a weak positive correlation between achievement and the use of elaboration cognitive learning strategies in the post-intervention survey (r=0.309, p=0.067). In contrast, metacognitive self-regulation had a weak negative correlation with achievement in the post-intervention (r=-0.356, p=0.050) survey. However, all other subscales had negligible correlation with achievement either before or after the intervention (see Table 6-3). Figure 6-2 shows that students achieving a pass or distinction grade reported lower use of most subscales, while the highest achieving students reported greater use of most of the learning strategies.

There were no statistically significant differences between final marks of students based on their high school science status (F=0.339, p=0.798, df=3).

Table 6-4: Pearson's Correlation Between Achievement and MSLQ Subscale.

		Pre-intervention				Post-intervention			
MSLQ	Subscale	Pearson r	P-value	lower 95% CI	upper 95% CI	Pearson r	P-value	lower 95% CI	upper 95% CI
Motivation	Intrinsic	0.028	0.872	-0.303	0.353	0.182	0.289	-0.156	0.482
	Extrinsic	0.014	0.937	-0.316	0.341	-0.013	0.942	-0.340	0.317
	Task Value	0.016	0.927	-0.314	0.343	0.112	0.514	-0.225	0.425
	Control of Learning Beliefs	0.139	0.419	-0.199	0.447	0.226	0.185	-0.111	0.516
	Self-Efficacy for Learning	0.360	0.031	0.035	0.616	0.535	0.001	0.250	0.734
	Test Anxiety	-0.061	0.723	-0.383	0.273	-0.055	0.748	-0.377	0.278
Cognitive strategies	Rehearsal	0.056	0.744	-0.277	0.378	-0.148	0.388	-0.455	0.190
	Elaboration	-0.144	0.556	-0.562	0.332	0.309	0.067	-0.022	0.579
	Organisation	0.003	0.985	-0.326	0.331	0.095	0.583	-0.241	0.410
	Peer Learning	-0.115	0.503	-0.428	0.222	-0.142	0.408	-0.450	0.195
	Critical Thinking	0.097	0.564	-0.239	0.412	0.107	0.535	-0.230	0.421
Metacognitive strategies	Metacognitive Self-regulation	-0.231	0.330	-0.595	0.211	-0.356	0.050	-0.630	-0.001
	Effort	-0.078	0.650	-0.397	0.257	-0.016	0.928	-0.342	0.315
Resource Management	Environment	0.013	0.956	-0.428	0.221	0.125	0.469	-0.213	0.435
	Help seeking	-0.116	0.500	-0.428	0.221	-0.089	0.605	-0.406	0.247

Note. Correlation size (r): <0.3 = negligible 0.3-0.5 = weak, 0.5-0.7 = moderate, 0.7-0.9= strong

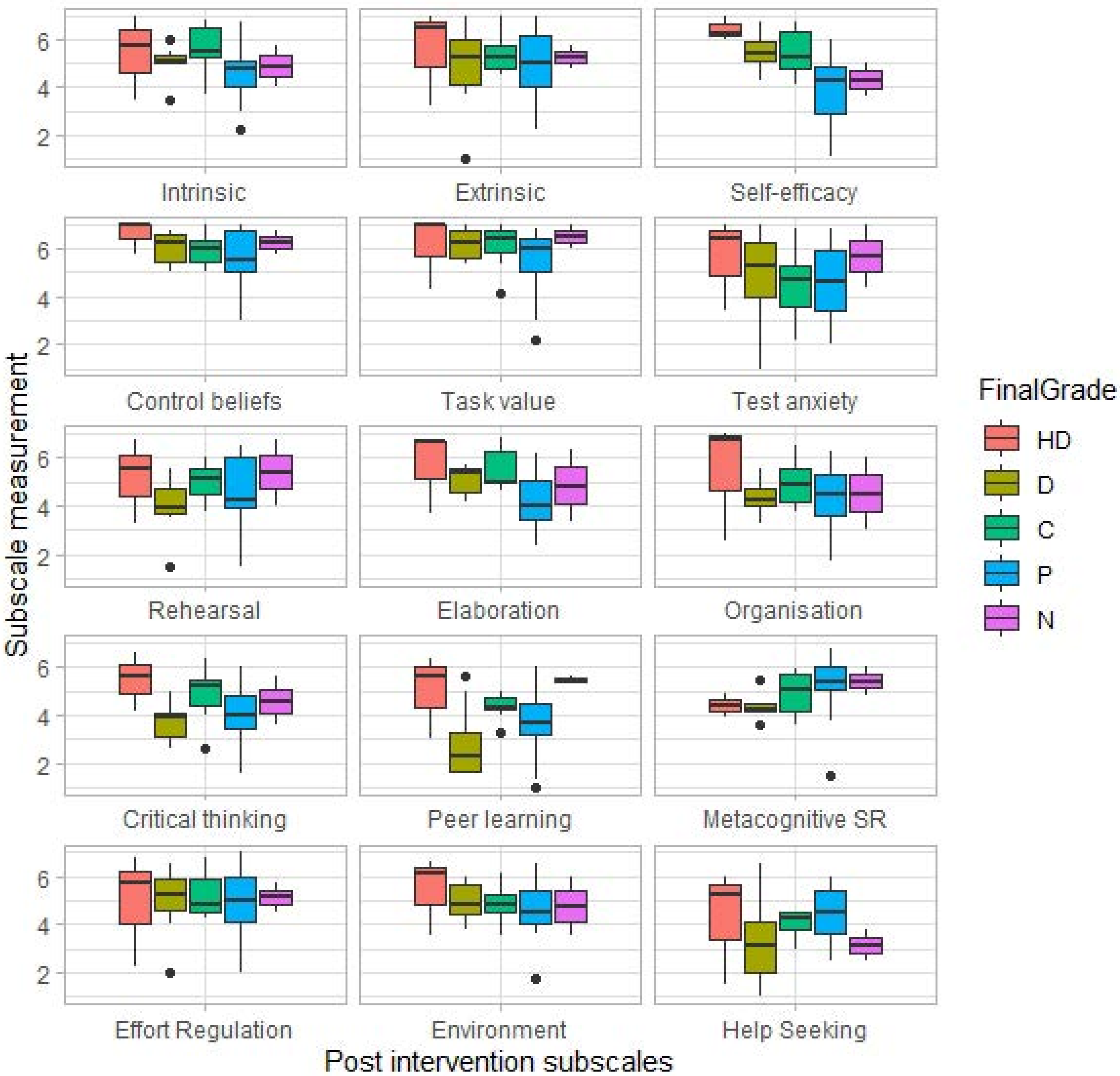

Figure 6-2. Box Plots of MSLQ Subscale Distribution for Each Achievement Level for the Post-Intervention Survey.

Note. The top six panels are motivation subscales, whilst the remaining nine are cognitive and metacognitive learning strategies and resource management strategies.

Trends in Student Motivation and Achievement. Student's views on the value of the bioscience subject to their future goals in health care were high across all grade levels, with almost all students in this study rating task value above 5, while the overall average was 5.9 on both the pre- and post-intervention questionnaires, with little variation between the different grade achievement levels (Figure 6-2). Equally, the goal orientation subscales both had relatively high means of 5 each. There was greater variation amongst the grades in intrinsic goal orientation as higher achieving students were more likely to have higher intrinsic goal orientation. Students across all grade achievement levels rated their extrinsic goal orientation similarly high. Control of learning beliefs amongst the participants was high, with an average of 5.8 (±1.04) and little variation between the grade levels.

Trends in Learning Strategy Use and Achievement. There were no clear correlations between grade achievement levels and the reported use of cognitive learning strategies. However, higher achieving students reported using all strategies to a greater extent than other grade achievement levels (see Figure 6-2). For high distinction level students, organisation strategies had the highest median, followed by elaboration and critical thinking, with rehearsal strategies the lowest. Surprisingly, distinction level students reported low use of all the learning strategies in the context of bioscience learning in this subject, which affected the overall correlations with achievement.

The correlation between the use of elaboration strategies and achievement increased from a negative correlation at the start of semester (r=-0.144) to a weak positive correlation at the end of semester (r=0.309). This was the learning strategy with the highest mean for distinction level students.

6.5. Discussion

6.5.1. Demographics

The effect of demographics on academic achievement and on self-regulated learning strategy use has shown inconsistent results in the literature. In a brief review of gender on academic self-regulation, Pintrich and Zusho (Pintrich & Zusho, 2002) note that there can be gender differences in motivation and strategy use, but these are often domain dependent. For example, females may have lower motivation in science and higher in humanities. In a review of correlates to academic achievement, Richardson et al. (2012) found that three demographic factors were reported in the literature: age, sex and socioeconomic status. However, they report that the effect size was small "(r^+s = 0.08-0.11)" (Richardson et al., 2012, p. 372). In the current study none of the demographic factors collected significantly affected achievement or the scores on the MSLQ subscales.

6.5.2. Comparison of Pre- and Post-Intervention Motivated Strategies for Learning Questionnaire Scores

There are limited studies investigating the change in MSLQ scores over a semester of learning. The number of studies within this category that include a learning intervention are also limited. In particular, learning intervention studies using the MSLQ are usually conducted within an extra-curricular subject where the main focus is on 'learning-to-learn', rather than being within the context of the content of the program of study (Montero et al., 2017; Pintrich et al., 1993; Steiner et al., 2019). It is important to note that these extra-curricular subjects are not compulsory, and often only attract highly motivated students. Findings from those studies usually indicate that training in self-regulated learning is beneficial (Hofer & Yu, 2003; Tuckman, 2003). The key difference with the current investigation is that it has been based on the recommendation that self-regulated learning training is potentially more beneficial when taught within the context it will be used (Hattie et al., 1996; Hattie & Donoghue, 2016) and embeds the training within a difficult subject area. This exposed all students, including motivated and unmotivated students, to the training. Although the changes over the semester did not reach statistical significance, there were positive trends in the motivation subscales and the use of cognitive learning strategies. It has been noted that using self-regulated learning strategies is "neither easy nor automatic" (Pintrich, 1999, p. 467; Zimmerman & Moylan, 2009), and that learning them takes time and effort (Halpern, 1998; Usher & Schunk, 2018; Winne, 2013). In addition, other investigations have found that students often fail to follow through with their study plans (Cao & Nietfeld, 2007; Dye & Stanton, 2017; Stanton et al., 2015). Furthermore, the current investigation (Chapter 7) also found that students still felt unable to undertake some of the learning strategies on their own at the end of the semester, indicating that more practice may be required.

A similar, but statistically significant trend, was identified in the current investigation of teaching without an intervention of first-year students (Chapter 3), which found that students with some prior experience in higher education were more likely to increase their use of self-regulated learning strategies from the start to the end of one semester. This suggests that it may be beneficial to undertake a longitudinal investigation of the students who undertook the intervention during their diploma studies and administer the MSLQ again during their first-year bioscience subjects. This would allow exploration of any further improvements in their learning strategy use, after having had additional opportunities for practicing the strategies (Pintrich, 1995).

Of particular note was the increase in student's reported use of critical thinking skills at the end of the semester (d=0.332). Although this increase did not reach statistical significance, it had a weak effect size. Critical thinking is a key skill required for clinical practice of nursing and allied health professionals. The intervention had a very strong focus on modelling and practicing making explicit connections between and within concepts covered by the subject, which may have contributed to the increase.

One aim of the intervention was to increase students' self-efficacy for learning bioscience. However, there was negligible change in this sub-scale. A similar result was found in the investigation of first year students (Chapter 3); however, when analysed further, the first-year students had significant changes in self-efficacy when previous experience in higher education was taken into consideration. In the current study, none of the demographics had any effect on self-efficacy, including previous higher education studies. There was some recalibration by low achieving students, who had over-estimated their efficacy at the start of the semester (Dunlosky & Rawson, 2012). This is evidenced by the increase in the strength of the correlation with achievement at the end of the semester.

In contrast to the increase in motivation and cognitive learning strategies, students reported a decrease in the use of the metacognitive and resource management strategies at the end of the semester. Although this did not reach statistical significance, this is of some concern because these subscales are often highly correlated with achievement (Credé & Phillips, 2011).

6.5.3. Achievement

A criticism of investigations of the 'bioscience problem' has been that measurements of student achievement are rarely included; instead, investigations have focussed more on student satisfaction, (Jensen et al., 2018; McVicar et al., 2015). These reviews also comment that nursing students often report satisfaction with bioscience subjects and individual learning activities, but that there is no correlation between satisfaction and achievement (Jensen et al., 2018; McVicar et al., 2015). Conversely, the MSLQ was developed using a number of empirically supported education theories related to student achievement including student motivations for learning and student information processing strategies (Pintrich et al., 1993). Furthermore, achievement has been correlated to MSLQ subscales in past investigations (Jackson, 2018; Kosnin, 2007; Ningrum et al., 2018; Pintrich et al., 1993; Roth et al., 2015).

6.5.4. Trends in Student Motivation and Achievement

A high intrinsic goal orientation has regularly been associated with higher achievement, due to the internal drive to understand information, rather than merely pass examinations (Linnenbrink & Pintrich, 2002; Lyke & Kelaher Young, 2006; Pintrich & De Groot, 1990). In the current study, the highest achieving students had the highest intrinsic and extrinsic goal orientation. All achievement levels had higher extrinsic goal orientation than intrinsic. This is consistent with other studies investigating the goal orientation of health science students, which show that nursing students in particular have high extrinsic motivation (Nilsson & Warren Stomberg, 2008; Perrot et al., 2001; Salamonson et al., 2013), particularly related to the overall goal of becoming a nurse. This is important, because bioscience subjects are a core requirement of the program, and that may be the only reason that many students undertake them.

The strongest correlation in the current study was between self-efficacy for learning and achievement, whereby those students who had the highest achievement also had the highest self-efficacy. Self-efficacy has repeatedly been correlated with academic achievement (Chacko & Huba, 1991; Honicke & Broadbent, 2016; Pajares, 2008; Zuffianò et al., 2013). Early work by Bandura (1997) suggests that self-efficacy affects students' choices around engaging with the content, and their persistence when difficulties arise. Bandura (1997, p. 215) illustrated this concept using data that showed that students with higher self-efficacy at a number of mathematics "ability levels" used more learning and problem-solving strategies than equivalent-ability students with low self-efficacy.

6.5.5. Trends in Learning Strategy Use and Achievement

Cognitive Strategies. In other studies using the MSLQ, there are generally positive correlations between the reported use of the learning strategies and achievement level (e.g., Ningrum et al., 2018; Pintrich et al., 1993). In the current study, this pattern of increase in use of strategies with increasing achievement was disrupted by the distinction level students, who reported much lower use of strategies than expected. As noted earlier, there was a very wide range of potential ability, as measured by entry ATAR, in this subject, as well as prior experience with biology and chemistry. Prior knowledge is reported to be a good predictor of future academic performance (Hailikari et al., 2008; Thompson & Zamboanga, 2004). It is plausible that distinction level students found this subject very easy because it was designed for the science naïve. Therefore, some of the information may already have been known to students with a high ATAR, or those that had completed high school biology and/or chemistry. Decisions about what, when and how to study are multifactorial and perhaps a distinction grade was acceptable to some students, given their competing priorities. Those students seeking a high distinction, whether to improve grade point average (extrinsic) or due to inherent interest (intrinsic) may be expected to choose to commit to the extra effort to achieve maximum scores. Interestingly, there was no significant difference in the amount of time spent studying by different grade level. Therefore, it would appear that higher achieving students are using the time more effectively. In the current study, higher achieving students reported relying less on surface level strategies such as rehearsal, and more on deeper learning strategies, which is consistent with other studies (DiFrancesca et al., 2016; Geller et al., 2018). However, they still report higher use of rehearsal than lower achieving students.

Rehearsal learning strategies are important in the initial phase of learning a new, complex body of knowledge for all students (Hattie & Donoghue, 2016; Shuell, 1990). Bioscience subjects may differ from non-science subjects in the amount of new information encountered by students over a teaching period. For example, in this subject, each week for the entire semester was a new topic area, meaning that students would need to continue using rehearsal learning strategies for the whole semester. Therefore, it would be expected that the use of rehearsal strategies would not decrease significantly by the end of the semester, and that students of all achievement levels would use this strategy. However, the high use of rehearsal strategies, with corresponding low use of other strategies by lower achieving students is an area that requires further improvement. This may, in-part, relate to students resorting to strategies that they are more familiar with and that were effective during high school studies.

It is possible that the variability in the reported use of other cognitive learning strategies may indicate that some students were beginning to implement the strategies taught during the intervention but were having mixed success. As noted in Chapter 7, some students reported still not feeling confident to implement them on their own. Furthermore, a study by Ainscough et al. (2020) reported that students who attempted new strategies achieved lower marks in the short term. It is possible that one semester is not long enough for all students within the intervention cohort to develop proficiency, particularly for those students who were less motivated to engage with the intervention, for example, students who do not see the necessity to change strategies, or those who discard them quickly when they are challenging.

Metacognitive and Resource Management Strategies. Although the correlations are not consistent with other studies (e.g., Pintrich et al., 1993; higher achieving students in this study still report greater use of most of the cognitive, metacognitive and resource management strategies than other students. However, students achieving an overall result in the range of 50.0% to 84.9% show inconsistent results, with both passing grade and distinction grade students reporting low use of metacognitive and resource management strategies within this subject. In another recent study, Jackson (2018) found a similar lack of correlation between achievement and metacognitive regulation. Several other authors have suggested that the metacognitive self-regulation subscale of the MSLQ may not be valid, at least in some student populations (Dunn, Lo, et al., 2012; Pintrich, 2004; Tock & Moxley, 2016).

In the current study, lower achieving students reported engaging in monitoring, but did not report correspondingly higher use of the deeper learning strategies (elaboration, organisation). Similarly, Stanton et al. (2015) reported that half of the students in their metacognitive intervention did not follow through with study plans made following metacognitive prompting. They developed a continuum that may also be relevant to this cohort. Students were classified as “not engaging” → “struggling” → “emerging” → “developing” in metacognitive monitoring. Their recommendation was that students may need more assistance with procedural knowledge; however, that knowledge was explicitly provided in the current study. Nonetheless, within this current study, only lasting the duration of one semester, there may have been insufficient time for students to adequately develop their proficiency with these new strategies.

6.6. Conclusion

Development of skills takes time and practice. Authors have noted that self-regulated learning skills are “neither easy nor automatic” (Pintrich, 1999 p. 467; Zimmerman & Moylan, 2009) and that even students who follow the training may not follow through with implementation (Bandura, 1986, 2012; Cao & Nietfeld, 2007; Pintrich, 1995; Stanton et al., 2015). However, it is better that students are made aware of the declarative, procedural, and conditional knowledge related to the strategies so that they have the opportunity to implement them either now or in the future. Pintrich (1995, p. 11) sums up the situation well with the following:

> *“becoming a self-regulated learner is not a task to be accomplished overnight, in a week or even during a whole semester. Students need time and opportunity to develop their self-regulatory strategies. Explicit courses, … can help students get started but students need to continue to practice and use the strategies over time after the formal course is completed”*

Therefore, it is encouraging that overall, the trends in changes of students’ self-reported motivation and learning strategy use were predominately in a positive direction after one semester of integrated instruction in learning strategy use. Pintrich’s (1995) assertion together with the positive trends suggest that the development of a meta-curriculum may be beneficial to nursing and allied health students use of cognitive and metacognitive learning strategies for processing, encoding and remembering of bioscience concepts. Integrating the meta-curriculum into subsequent subjects may help increase students’ familiarity and use of the learning strategies further by continuing to emphasise their importance. As students continue to practice, the strategies will become internalised and using them will require less conscious effort.

6.7. Future Recommendations

Further development of the metacognitive components of the intervention are required, particularly with ensuring that students are actually undertaking the appropriate self-evaluation. In this study, the prompts were given, but there was no way to know if students did the activities. Nursing and allied health students have high extrinsic motivation, therefore, a potential way of increasing student engagement with the activities may be to give students credit for answering the metacognitive prompting. This was effective for higher level students in studies by Colthorpe and colleagues using meta-assessment tasks (Colthorpe et al., 2017, 2019b). In addition, the intervention study should be repeated with first year nursing and allied health students. Finally, a longitudinal component should be added to investigate whether this type of early learning intervention has benefits for students later in their programs.

7. Insights into students' learning strategy use after completing a bioscience subject with embedded self-regulated learning strategies.

7.1. Abstract

Background: Biosciences are often difficult subjects for nursing and allied health students, many of whom may be science avoidant. Self-regulated learning strategies have been associated with higher academic achievement. Self-regulated learning strategies include cognitive, metacognitive and resource management strategies that assists students to reach their learning goals. A learning intervention that embedded the explicit instruction of learning strategies with the bioscience content was delivered within a foundation subject designed for nursing and allied health students.

Aim: To explore the learning strategies used by participants in preparation for the final examination following a self-regulated learning strategies intervention.

Design: Exploratory qualitative.

Participants: Nine students who participated in a bioscience subject with an integrated self-regulated learning intervention agreed to be interviewed.

Methods: Semi-structured, face to face interviews were conducted. Interviews were audio-recorded, transcribed, and thematically analysed using a semantic deductive approach. Self-regulated learning theory was used as the theoretical framework, by using the Motivated Strategies for Learning Questionnaire (MSLQ) for coding. Some discussion of the relationship with the student approaches to learning perspective was also included.

Findings: All but one of the subscales of the MSLQ could be identified within the participant transcripts. Participants described using more deep learning strategies than shallow learning strategies in preparation for their exams. Most learning strategies described by participants were cognitive strategies used within the performance phase of the cyclical model of self-regulated learning. However, participants described using peer learning and retrieval practice as methods of self-evaluation. Participants provided their perspective on many of the learning strategies that had been explicitly taught during the intervention. Three key themes were identified: openness of the students to try new learning strategies, the importance of making connections between concepts and time-poorness.

Conclusion: Several of the strategies included in the intervention were new to the participants, and whilst they found the strategies useful, participants were not always confident in implementing them independently. From a resource management perspective, students have very limited time for independent study, and thus have a need for experience in the use of effective learning strategies.

Overall, the intervention appears to have been beneficial to these participants because it increased the repertoire of learning strategies available to them.

7.2. Introduction

The purpose of this investigation was to gain a deeper insight into students' experiences in preparing for the end of semester examination following a full semester self-regulated learning intervention. The intervention was focussed on increasing students' knowledge and use of cognitive and metacognitive learning strategies associated with self-regulated learning theory.

The learning intervention that was delivered to the students involved explicit instruction in identified cognitive, metacognitive and resource management learning strategies within the context and content of a foundation bioscience subject (see Chapter 5). This subject was selected due to the extensive literature reporting difficulties experienced by nursing and allied health students in bioscience subjects (Jensen et al., 2018; McVicar et al., 2014, 2015). Biosciences are an important foundation to the clinical reasoning that will be required in these professions, and thus are a core component of nursing and allied health programs. This foundation bioscience subject provided an opportunity to prepare students with both prerequisite content knowledge, and also contained a unique inclusion of an intervention that provided the declarative, procedural and conditional knowledge of experimentally effective learning strategies, which are useful for interacting with and learning this specific content.

The learning strategies taught during the intervention were based on the theoretical framework of self-regulated learning, which conceptualises learning as a cyclical process of planning, performing and evaluating (Pintrich, 2004; Zimmerman, 2000a; Zimmerman & Moylan, 2009). Therefore, the intervention presented bioscience content within learning cycles and included explicit instruction in a range of cognitive, information processing techniques such as concept mapping, extracting important information, compare and contrast, cause-and-effect thinking, peer learning, along with metacognitive self-regulation techniques such as task analysis, planning, self-evaluation, effort regulation, and resource management techniques such as time management and help seeking. A learning cycle was made up of the three phases of Zimmerman's cyclical model of self-regulated learning (Zimmerman & Moylan, 2009).

The first phase of each content topic was the forethought phase, where learning outcomes were presented as the goals for the topic. Planning and task analysis were emphasised during this phase, for example, understanding the meaning of task verbs in learning outcomes and how they relate to the level of content understanding expected. The second phase was the performance phase. During this phase explicit instruction in the content and the learning strategies was delivered.

Time for practicing both application of the content and the learning strategies was provided during a practical session. Collaborative learning in small groups was the main teaching method during these sessions. The final phase of the cyclical process is self-reflection. This phase began towards the end of the practical session, with a review of the learning outcomes, and continued with the provision of a number of self-testing opportunities for students to undertake during their independent study time.

Therefore, the research questions of interest were:

1. What learning strategies were students using to prepare for the final examination?
2. Was their use of learning strategies influenced by the learning intervention?

7.3. Methods

This study used a descriptive qualitative design as described by Sandelowski (2000, 2010), a technique that applies less interpretation on the part of the researcher. This type of design is "especially amenable to obtaining straight and largely unadorned (i.e., minimally theorized or otherwise transformed or spun) answers to questions of special relevance to practitioners and policy makers" (Sandelowski, 2000, p. 337), by not "reading *into*, *between*, *over* or *beyond* lines" (Sandelowski, 2000, pp. 335–336). This level of interpretation is consistent with the semantic approach to thematic analysis described by Braun and Clarke (Braun & Clarke, 2006, 2022), which was used for data analysis. Semantic thematic analysis is concerned with straightforward interpretation of interview transcripts rather than searching for hidden meanings in participant responses. It is often used with pre-existing frameworks in a deductive, top-down fashion.

7.3.1. Participant Selection

All 86 students who participated in the integrated intervention were invited to participate in the interviews via a link on the learning management site. The link was advertised to the students once, then no further contact was made by the researcher. In addition, no inducements were offered for participation. These steps were taken to ensure that the students did not feel coerced into participation.

The planned number of participants for individual interviews was 6 to 12 (Guest et al., 2006), due to the narrow scope of the study and the small size of the target group (Malterud et al., 2016). In addition, Malteraud et al. (2016) note that exploratory studies do not seek "to cover the whole range of phenomena, but to present selected patterns relevant for the study aim" (Malterud et al., 2016, p. 1756). A total of nine students registered and attended an interview during the final week of semester after all teaching was completed but prior to the end of semester examination, six as individuals and three as a group. No repeat interviews were carried out. Table 7-1 summarises the demographic characteristics of the participants. The majority of interview participants were female (77.7%), which was slightly higher than the entire sample population (64.5%). Just under half (44.4%) of participants were in the 25-29 age range, which was higher than the entire sample population (9.3%), while 11.1% of the participants were under 19 years old, which was lower than the entire sample population (51.5%). The percentage of participants in the 30-34 age range (33.3%) was comparable with the entire sample population (30.9%).

Table 7-1: Demographic Characteristics of the Participants

Participant	Goal for future studies[1]	Gender	Age range
A	Nursing	F	20-24
B	Occupational Therapy	F	20-24
C	Nursing	F	30-34
D	Nursing	F	25-29
E	Occupational Therapy	F	25-29
F	Nursing	F	<19
G	Physiotherapy	M	25-29
H	Medicine	M	25-29
I	Physiotherapy	F	20-24

[1]Participants all stated their goal program during the interview.

7.3.2. Data Collection

A semi-structured interview guide was developed in consultation with the research team to allow for a more organic conversation than would be possible with a fully structured list of questions. The questions were open-ended and focused on students identifying the learning strategies they were using in preparation for the final examination (see Table 7-2). Probing questions were used during the interviews to further explore responses. Interviews lasted between 19 and 35 minutes for individual students and 52 minutes for the group of three. Interviews were recorded and then transcribed verbatim by a third-party transcription company. Transcripts were not returned to participants for confirmation.

The interview phase of the investigation was carried out at the end of the semester, following all teaching but prior to the end of semester exam, after a relationship between the lecturer and the students was well-established. Therefore, the interviews were conducted by an academic from outside of the research team and outside of the subject teaching team to reduce the prospect of participants feeling pressure to give socially desirable answers. The interviewer was an experienced, female, senior academic with doctoral qualifications who also had experience in conducting interviews and focus groups. The interviews were conducted in the interviewer's office on campus, and only the interviewer and participant were present. Six participants chose to attend solo interviews and three participants (G, H, I) chose to attend as one group.

Table 7-2: Questions Used to Guide the Semi-Structured Interviews.

Interview question guide
Which learning strategies have you been using specifically to make your studying as effective as possible for the upcoming exam?
Did you change your approach to studying or methods of studying as the semester progressed, if so, what triggered these changes? In what ways have your approaches changed? Did these changes help improve your understanding of physiology? How do you know?
Do you feel like you have met/will meet your academic goals in this subject? If not, what factors hindered your ability to do so? If so, what do you attribute this to?
Did you try out any of the learning strategies discussed during the lectures? If so, how did you feel about those strategies? If not, what stopped you from trying them?
Which of the strategies that you used this semester will you continue to use in your ongoing study? Why?

7.3.3. Ethics Approval

This study was part of a larger study granted full ethics approval by a regional university Human Research Ethics Committee (approval number H7611) in accordance with the National Statement of Ethical Conduct in Human Research. Students were provided with information outlining the investigation, including that interviews were confidential but not anonymous, and that the interview would be recorded for transcription.

7.3.4. Data Analysis

Thematic analysis as described by Braun and Clarke (2006, 2022) was used to analyse the data. This method of analysis is quite flexible, in that it is not tied to particular epistemological or theoretical perspectives (Braun & Clarke, 2022; Maguire & Delahunt, 2017). However, of the many persuasions of analysis described by Braun and Clarke, this study focusses on using the theoretical lens (deductive) of self-regulated learning to explore the participants' perspectives and understanding of using various learning strategies in preparation for their final exam (experiential) by analysing their words at a more surface or explicit level (semantic). Braun and Clarke (2006, 2022) recommend a six-step process for analysing qualitative data thematically. The first step is to become familiar with the data, this was achieved by reading and re-reading the transcripts and making summaries of individual transcripts and making more general summaries across all transcripts.

The second step is to generate initial codes. Semantic deductive coding was used during this step. The theoretical framework used for coding was the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1991). The MSLQ is a self-report instrument used to measure students' motivations towards their studies and their use of cognitive, metacognitive and resource management learning strategies. The questionnaire has fifteen subscales separated into two sections. The first section is factors affecting motivation, this section includes six subscales measuring goal orientation, control of learning beliefs, task value, test anxiety and self-efficacy. The second section has nine subscales that can be further grouped into cognitive learning strategies, metacognitive self-regulation strategies and resource management strategies (as shown in Table 2). The metacognitive self-regulation scale of the MSLQ attempts to capture the cyclical aspects of self-regulated learning that were described by Zimmerman's (2000) cyclical model of self-regulated learning. The items in that subscale address three general process: planning, monitoring, and regulating, or following through with adjustments. Because these are distinctive phases in the cycle, they have been separated for coding.

NVivo 12 plus was used to organise the coding. Examples of the types of comments included in each of the initial codes are shown in Table 7-3. Comments related to fourteen of the fifteen MSLQ subscales were identified. Participants did not make any comments which could be related to their control of learning beliefs.

Following initial coding, the next step in thematic analysis is to identify larger patterns over the entire dataset by grouping similar codes into preliminary themes, ensuring that themes were consistent with all of the data included within each theme (Braun & Clarke, 2006; Peel, 2020). In discussing theme development, Braun and Clarke (2022, p. 8) have elaborated on core assumptions of reflexive thematic analysis, noting that themes are patterns of ideas rather than summaries, and that they are actively produced by the researcher rather than something that passively emerges from the data. Furthermore, they state that "good coding can be achieved alone" (Braun & Clarke, 2022, p. 8) and that if collaboration is used it should be about developing understanding not consensus.

7.4. Findings

7.4.1. Motivation for learning

Despite the conflicts between life and study, and although the participants were not directly asked about their feelings or motivations towards the subject, it was clear that the participants were both highly intrinsically and highly extrinsically motivated to study bioscience (see table 7-3). Participants regard the bioscience subjects as necessary and important for their future careers (task value Table 7-3). Most participants did not directly discuss their self-efficacy beliefs during the interview. There was just one participant who alluded to their low belief in their ability to pass the subject.

7.4.2. Cognitive Learning Strategies

All the cognitive learning strategies covered by the MSLQ could be identified in the interview transcripts (Table 7-3). However, individual participants described using a limited range of cognitive strategies when studying and reviewing the content of this subjects. Some of the strategies explicitly taught during the intervention were described by the participants. Two strategies that were discussed by most participants were peer learning and retrieval practice. Participants described several different ways of using both strategies.

Peer Learning. All participants described peer learning as being very beneficial to their understanding of the content. There were two main ways that peer learning was used. The first was as a method of seeking additional information, which is how it was categorised by Zimmerman and Martinez-Pons (1986) in their description of the 14 learning strategies used by self-regulated learners. *"Well, I usually use my friend for help because sometimes I don't understand it…[if] we both don't understand we go either search for it or we ask the teacher" (Participant F).* This also aligns with item 68 of the MSLQ, which is one of three items in the peer learning subscale: When I can't understand the material in this subject, I ask another student in the class for help.

The second was as a method of self-evaluation, with one participant noting that *"the way I would judge how I've learnt and what I've learnt is explaining it to other people" (Participant B)*, which aligns with item 34 of the MSLQ: When studying for this class I often try to explain the materials to a classmate or friend. Several participants also described how the act of teaching others helped them to realise where they needed to focus their study: *"I was kind of going over all these*

Table 7-3: Coding scheme developed from the subscales of the MSLQ, with examples of comments from the interview transcripts of the strategies as described by the participants.

Coding Scheme		Example responses
Motivation	Intrinsic motivation	"I feel good when I understand it"; "so interesting. I love this subject"
	Extrinsic motivation	"I just want to do well" "I want to pass this year with a certain GPA"
	Self-efficacy	"I've just got to personally get my head around it. It's nothing to do with the subject at all. It's just me"
	Test anxiety	"it's just my mind would go blank"; "there's stress around exams"; "stress levels [for upcoming exam] are not high at all"
	Task value	"but it's so necessary, like, for going into anything beyond this, like I feel it really sets the foundation for the basic concepts of physiology and anatomy, which is good"; "it's kind of where I want my pathway to lead essentially"
Cognitive Strategies	Rehearsal	"I have to draw things over and over again"; "rote learning, I think it's called, rote learning where you write it out"
	Elaboration	"write myself a question and then have to answer in my own words"; "summaries of what was in the chapter"; "write it in my own words to like gain a better deeper understanding"
	Organisation	"the most useful one I found to remember the information was the concept maps, they were amazing"; "I have to draw a picture and then how it connects everything"
	Critical thinking	"and then once you start relating material from one topic that you did to another, then I was kind of understanding"
	Peer learning	"working in a group is way more effective"; "I find teaching them how to do the exercises actually more helpful than doing them"; "there's different strengths within our group"
Resource Management	Time and Environment	"I'm so time poor"; "not using the time that I had as effectively as I could of"; "time management, but that is something I'm quite good at"
	Help seeking	"youtube videos"; "I have to google what they look like"; "I would, and my friend as well, we just ask [the lecturer] questions"; 'I'm the first one to ask if I don't understand, otherwise you're not going to learn"; "writing down questions that you don't understand in the book"
Metacognitive Strategies	Effort Regulation	"started doing, like, Pomodoros and stuff like that"; "I need to keep pushing myself otherwise I won't – I'll slack off because I get very lazy sometimes"
	Metacognitive Regulation	
	• Planning	"instead of studying the whole mass of it and trying to absorb as much information as I can, pinpointing the most important things"; "I'll add to the study periods that I have pre-allocated, like little outcomes that I want to do, so like summarise this topic, go over these notes"
	• Monitoring	"go on to Quizlet and search up quizzes that relate to the subject…to see if I would be able to know stuff"; "so you get it wrong but you get the feedback and then you go 'Oh, that's what it is'"
	• Regulating	"realised that reading was not working"; "I would never have thought to use a concept map"; "one huge thing that I've noticed that made a huge difference along with the flashcards is the compare/contrast, which I never did before"; "I always thought that repetition would get me there but that doesn't actually get you to understand"; "you have to change the way of learning depending on what you're learning"

bits [explaining to another person] and then I realised, actually, there's a key point that I'm missing in the middle of how it ties together" (Participant D); "I especially do that [explain to others] in my workshop because the people I'm with, they don't really understand it as much, so I find teaching them how to do the exercises actually more helpful than doing them…because I've known that by teaching other people some sort of things sort of clicks as well in that situation" (Participant F); *"when you, like, explain it to someone else, it helps you understand it better because you're trying to explain it in a comprehensive way. So that's really helpful, yeah" (Participant I).*

Participants also noted that one of the benefits of peer learning was that differences in understanding of concepts by group members could be integrated into a more complete understanding: *"she gets certain things and I get certain things and we can kind of relate it to each other in a way that we would understand" (Participant F); "there's different strengths within our group so one of us might not get this aspect but the other person does… the other person gets a chance to explain it and it sort of helps everyone out in that regard" (Participant H); "yeah, I think on some levels it's easier to learn from another student because they've just recently gone through the process of acquiring that information" (Participant H).*

Retrieval Practice. The intervention provided several opportunities for students to use retrieval practice within the learning cycle of each topic. Audience response software was used during the lectures, there were chapter revision questions at the end of each chapter of the online textbook and an asynchronous Kahoot! was available for each topic. Participants who described a high level of engagement with these resources explained that they were using the strategy as a form of self-evaluation (see Table 7-3).

Therefore, in addition to being used as specific cognitive learning strategies, both peer learning and retrieval practice were also used by the participants for their self-evaluation (Metacognitive Self-Regulation strategy). Furthermore, student use of retrieval practice is not detectable with the questions in the MSLQ. However, during coding it was placed under self-evaluation as it has the potential to provide students with feedback about their comprehension and memory.

7.4.3. Resource Management

Most participants spoke about ***being time poor***. Participants described a variety of commitments that reduced the amount of time they had available for studying, such as caring for children, running small businesses, working full-time or multiple part-time jobs and working odd or unpredictable hours. Some participants described highly effective time management strategies, while others noted that this was an area where they could improve.

"Well, to be honest, I'm probably not the best student because I'm so time poor. I guess, all the students are time-poor, it's just like, running the business as well as doing uni part-time and then, obviously, all the other extra things that - husband and all that stuff. Like, I definitely think I'm doing the bare minimum that is required. Not that I'm proud of it or anything, but… " (Participant E)

For this participant, the "bare minimum" meant making full use of scheduled face-to-face time due to limited opportunities to engage in independent study.

At the other end of the spectrum, some participants had very good strategies for managing independent study time:

"I've been quite lucky in that I've been able to get a really predictable schedule, I use like a Google calendar, I go these are my work hours, these are the study hours and then as I go through each week, I'll add to the study periods that have pre-allocated, like little outcomes that I want to do, so like summarise this topic, go over these notes, like whatever subject it is and just come up with little goals, so that way - and it's usually like just three or four things, nothing major" (Participant H)

7.4.4. Metacognitive Self-Regulation Strategies

There was some discrepancy between participants who could articulate what they were doing and why, and those who couldn't. For example, when participants were asked how they know their strategies are working, some participants found it difficult to explain: *"it's hard to explain. It's like connecting all the dots" (Participant A)*, *"it's hard to explain how you have to change your way of learning, depending on what you're learning" (Participant B)*.

7.4.5. Effect of the Intervention

There was a clear theme around ***openness to trying new learning strategies***. This theme had three sub-themes. First, some participants came to that conclusion that they needed to modify their strategies on their own: *"I always thought that repetition would get me there but that doesn't actually get you to understand" (Participant B); "in my mind, I thought I was doing study because I was just rewriting. … I wasn't connecting the dots, so I had to change" (Participant D)*. Second, other participants were helped to expand their repertoire by the intervention: *"I have never thought to use a concept map or mind map" (Participant C); "I never before used to mind map…it wasn't until I started to mind map it … that I started to understand it" (Participant D)*. Finally, although open to trying new strategies, some participants felt some strategies were difficult to undertake on their own: *"I admittedly don't do it enough, like I always participated in class…and found them so useful but really struggled writing them out myself" (Participant I)*.

A second theme concerning cognitive learning strategies was ***the importance of connections*** between concepts within the bioscience subject.

> *"I felt the way that I've changed my strategy has helped me link things together. So, before, I was just looking at them as individual parts" (Participant D).*

> *"I understand that they're not going to be looking for just the random knowledge, they're looking for the main underlying stuff" (Participant F).*

7.5. Discussion

7.5.1. Cognitive Strategies

There are two main ways of conceptualising student motivation and learning, the self-regulatory perspective and the student approaches to learning perspective (Pintrich, 2004). Pintrich (2004, p. 403) argues that while the self-regulated learning perspective offers greater flexibility in combining different motivations and strategies of students in a research context, the student approach to learning perspective "has the advantage of being relatively simple and easy to understand, especially for faculty who are not [education] researchers", and therefore, can be helpful for instructors' effort to improve teaching.

The student approach to learning perspective refers to students having a surface approach to learning, whereby they focus on rote learning and replicating material; or a deep approach, whereby they use strategies that develop connections between concepts that facilitates deeper understanding and the ability to apply knowledge in new situations. (Biggs, 1993; Pintrich, 2004). The MSLQ contains more subscales that correlate with a deep approach to learning than to a surface approach (Entwistle & McCune, 2004). All but one of the cognitive learning strategies (rehearsal) are deep learning strategies, while the metacognitive and resource management strategies also aim for deeper learning, by assisting students to monitor their comprehension and modify their strategy use when needed.

Students' understanding of the content is a result of their use of various surface and deep cognitive strategies (Dunlosky et al., 2013) during the performance phase of the self-regulated learning cycle. The metacognitive monitoring of comprehension and self-evaluation against learning goals should determine students continued use, or adjustment of the cognitive strategies. Therefore, if students do not possess knowledge and experience in a range of potentially suitable cognitive strategies, learning, and subsequently, achievement, will be affected.

Most of the participants in this study described using learning strategies that foster a deep understanding, such as concept mapping and other ways of purposefully making connections between concepts. Participants appeared to be less reliant on rereading, and rehearsal strategies. It should be noted that the use of some surface learning approaches, such as flashcards for vocabulary, is important at the beginning of learning a new and complex body of knowledge (Shuell, 1990) and therefore, should be expected throughout a foundation subject. However, the transition to the use of deeper learning strategies must occur to enable a full understanding (Hattie & Donoghue, 2016; Shuell, 1990). The move to deeper learning strategies will be beneficial to application of bioscience knowledge in the clinical setting.

There has been an assumption that adult learners have a sufficient repertoire of cognitive learning strategies, which were internalised during their primary school education (Dignath & Büttner, 2008; Hattie et al., 1996; Jansen et al., 2019). However, this is contradicted in the current study, with participants indicating that some of the cognitive learning strategies were new to them. Intervention studies that purport to include cognitive strategies often report small effect sizes (Hattie et al 1996; Jansen et al 2019). However, strategies are often not fully described so it is difficult to discern the depth of understanding that the strategy may provide. In a description of a typical university study skills program provided by Hattie et al. (1996) no cognitive strategies were described.

7.5.2. Resource Management

The participants in this study described being time-poor, with most participating in part-time paid employment, as well as having family caring responsibilities. Student participation in part-time employment and its effect on academic achievement have been widely investigated within nursing and other students in Australia and internationally (Barker et al., 2016; Mitchell, 2020; Phillips et al., 2016; Salamonson et al., 2012, 2020; Snelling et al., 2010). Most students undertaking paid employment are doing so to be able to support themselves to attend university and many would rather not be working (Curtis & Williams, 2002; Mitchell, 2020). Some studies have suggested that less than 16 hours of work per week may not have detrimental effects on academic achievement (Phillips et al., 2016; Salamonson et al., 2012). However, regardless of the number of hours worked, students have reported that it impacts on the amount of time that they have available to study (Mitchell, 2020), which is consistent with the current investigation.

This lack of time could interfere with independent study and academic achievement in several ways. First, students may be less likely to seek assistance from external student services such as study skill centres. Therefore, providing practice in using learning strategies within the context of individual subjects may become increasingly important. Secondly, if students perceive a learning strategy as requiring too much effort, they may abandon it. According to Biwer et al. (2020), students are very good at estimating the amount of effort a strategy will take, but not at estimating the amount of benefit it will provide. Many of the learning strategies taught in the intervention were quite effortful, requiring students to think more deeply about the content and the connections within and between topics. The opportunity to practice the strategies in class with feedback, and with the bioscience content, was important to allow students to experience the benefits of the strategies. Participants noted both that some of these learning strategies were new to them, and that they found them beneficial. However, some participants noted that they had difficulty implementing strategies on their own. It is unclear whether this was due to the amount of effort required, or because the understanding of the procedural and conditional knowledge of the strategies was still developing. Given that students feel that they are time-poor, it is important that they have knowledge and experience with effective learning strategies so that they are able to use their limited time effectively.

7.5.3. Metacognitive Self-Regulation Strategies

Participants descriptions of their preparation for the final exam focussed mainly on the cognitive strategies discussed above, with almost no discussion about the planning phase. There was some discussion of the evaluation phases of the learning cycle, predominantly about the use of peer learning and retrieval practice as methods of self-evaluation. This is similar to the findings of Colthorpe and colleagues (2015, 2017, 2019b) who used a meta-assessment task to collect information about second year allied health students use of self-regulated learning strategies across the three phases of the learning cycle. They found that most students did not use all three phases of the learning cycle, with most students mentioning strategies from the performance phase and a minority of students mentioning the planning or self-reflection phases. That study also found that students who use strategies from all three phases perform better than students who rely on the performance phase only.

There was some indication that participants of the current study adjusted their strategy use over the semester either as a result of realising that something was not working or as a result of trialling new cognitive learning strategies. Some studies show that not all students will make adjustments, even in the face of failing results (Blasiman et al., 2017; Cao & Nietfeld, 2007; Stanton et al., 2015). There has been some discussion of factors that contribute to lack of follow through with plans to change strategies. Blasiman et al. (2017) suggest lack of understanding of effective learning strategies is a contributing factor, along with time-poorness, and an insufficient understanding of themselves as learners. While Biwer et al. (2020) and de Bruin et al. (2023) suggest that lack of perseverance with more effortful, but more effective strategies, is a factor.

Stanton et al (2015) proposed a continuum of metacognitive regulation amongst introductory biology students that appears applicable to the participants in the current study. The continuum begins with students who are not engaging and/or are unwilling to engage in reflection and adjustment, through those who are struggling, to those who are emerging and ending with those who are developing good reflection and follow-through and have knowledge of a variety of cognitive learning strategies. The authors found that the two extremes were rare in their study. Most participants in the current study would be classified as emerging moving into developing, in that they can describe procedural knowledge and they are beginning to understand self-evaluation and metacognitive regulation skills, and to make some adjustments to their strategy use.

7.5.4. Effect of the Intervention

Most participants indicated that the embedded instruction in self-regulated strategy use did influence their choice of learning strategies for learning and remembering the bioscience content. There was evidence of participants using more effortful strategies that will be of greater benefit for understanding the content at a deeper level. Some of these strategies were new to the participants, and thus increased their repertoire of learning strategies for the future. There was also evidence of students adjusting their strategy selection. While this can lead to lower academic achievement in the short-term as students develop proficiency with the strategies, it has been shown to lead to higher achievement in the longer term (Ainscough et al., 2020; Colthorpe et al., 2017).

Of note was the participants discussion of retrieval practice, which is considered a highly effective strategy for long-term learning even with complex concepts (Biwer et al., 2020; Dunlosky et al., 2013; Karpicke & Aue, 2015).

7.6. Conclusion

The intervention was beneficial in that it introduced some strategies that students had not considered and provided an opportunity to practice the strategies in context. However, it was still difficult for some students to implement the strategies on their own. Further practice may improve their use of the strategies, and it would be useful to re-evaluate the participants' transferral of strategy use to future bioscience subjects.

7.7. Limitations

A limitation to this study is that the self-selection of participants may have resulted in some selection bias. Students who participated may have been more willing to embrace deeper approaches to learning, and those students with a focus on surface learning approaches may not have wished to engage in an interview about their exam preparation. Thus, a more purposive sampling method where students were identified based on the level of achievement may have provided further insight into a wider range of student experiences with the intervention. Purposive sampling procedures should be included in ethics applications to ensure that they are conducted without students feeling coerced.

8. Chapter 8: Student Perceptions of Changes to Self-Regulated Learning Strategy Use Caused by Emergency Remote Teaching at The Beginning of COVID-19 Lockdowns: A Mixed Method Investigation.

8.1. Abstract

Background: In March 2020, the World Health Organisation declared Coronavirus disease (COVID-19) a global pandemic. Most universities pivoted from face-to-face teaching to emergency remote teaching. This study investigates the self-regulated learning strategy use of students in first-year bioscience subjects at the beginning of emergency remote teaching using the Motivated Strategies for Learning Questionnaire (MSLQ). Correlations between MSLQ scores at that time and final mark in the anatomy and physiology subject were also investigated. In addition, an analysis of student perceptions of changes to their learning strategy use was undertaken.

Research questions: 1) What were the MSLQ profiles of students at the beginning of emergency remote teaching; 2) What were the correlations between MSLQ scores and academic achievement during emergency remote teaching; 3) What were students' perceptions of the impact of the shift to emergency remote teaching on their learning strategies? 4) Did students believe that the shift to emergency remote teaching changed their use of self-regulated learning strategies and how did their perceptions of this change affect their MSLQ profile?

Design: Mixed method cohort observational design

Settings: An Australian regional university

Participants: First year undergraduate nursing and allied health students studying human anatomy and physiology, hereafter referred to as their bioscience subject.

Methods: The Motivated Strategies for Learning Questionnaire (MSLQ) was distributed to students enrolled in first semester, first-year bioscience subject in nursing and allied health programs, during the first two weeks of COVID-19 lockdown and emergency remote teaching. In addition, an open-response question was added to allow students to describe their perception of the changes. These responses were thematically analysed.

Results: Spearman's correlation analysis of achievement and the fifteen MSLQ subscales showed significant positive, low to moderate correlations with eight subscales, along with a significant negative correlation with test anxiety.

Most participants (81.5%) reported feeling that emergency remote teaching caused them to change the way they study. Just under half of participants (48.1%) described positive changes to their strategy use, while 44.4% described negative changes in strategy use. Those students who described positive changes in their strategy use also reported significantly higher scores on the MLSQ subscales for metacognitive self-regulation (p=0.020), effort regulation (p=0.001), time and environment management (p=0.011) and self-efficacy (p=0.022), along with a higher final grade (p=0.022).

Inductive semantic thematic analysis of the open-ended question separated the responses into two broad themes, participants who reported a positive change in their strategy use and those who reported a negative change. Those reporting a negative change were concerned about loss of motivation and difficulty with effort regulation. Those reporting positive changes appreciated the increased flexibility and responsibility. Both groups reported missing the social aspect of face-to-face learning.

Conclusions: MSLQ scores at the beginning of lockdown were predictive of students' final mark in their anatomy and physiology subject. Students who reported good use of metacognitive and resource management strategies and high self-efficacy for learning bioscience also had a more positive outlook on the sudden change in learning environment.

Keywords: self-regulated learning, bioscience, COVID, metacognition, motivation

8.2. Background

In March 2020, the World Health Organisation declared coronavirus disease (COVID-19) a global pandemic (World Health Organisation, 2020). This led to most universities ceasing face-to-face teaching and implementing a modified, and rapidly constructed and deployed, version of online teaching, which has become known as emergency remote teaching (Hodges et al., 2020; Hodges & Fowler, 2021). Therefore, students were forced to study online, after having chosen to attend university in person. A number of challenges and stressors were identified that impacted students during this time, both personal and academic (Haikalis et al., 2022; Martin, 2020).

During the transition to higher education, students generally experience a greater level of autonomy than they had at secondary school (Briggs et al., 2012; Dresel et al., 2015). However, during emergency remote teaching, students were required to engage in even greater levels of autonomy (Biwer et al., 2021; Martin, 2020). Successful autonomous learning requires students to be skilled in planning, monitoring, and adjusting their learning behaviours to reach their academic goals (Zimmerman, 2002). Therefore, self-regulated learning theory may be a useful lens to examine the student experience during emergency remote teaching.

Self-regulated learning includes three types of learning strategies, which are used across three phases of an iterative learning cycle. The learning strategies can be broadly classified into cognitive, metacognitive and resource management strategies (Duncan & Mckeachie, 2005). Cognitive strategies include the processes of encoding information for understanding and remembering, e.g., rehearsal, elaboration and organisation strategies (Weinstein & Mayer, 1983). Metacognitive strategies include monitoring of comprehension and monitoring of behaviour and therefore incorporates activities like task analysis, self-reflection and self-reaction (Pintrich, 2000; Zimmerman, 2000a). To be able to plan and monitor effectively, students need to have appropriate knowledge of the use and utility of a range of cognitive strategies. Resource management strategies include managing time and environmental conditions (e.g., distractions) and help seeking.

The learning cycle consists of a period of planning for the learning known as the forethought phase; a period of undertaking the learning, known as the performance phase; and a period of evaluating the learning, known as the self-reflection phase (Zimmerman, 2002).

In addition, self-regulated learning theory also considers several aspects of motivation for learning which may impact students' ability to self-regulate. These include goal orientation, self-efficacy for learning the content, control of learning beliefs and task value.

This study examined the self-regulated learning profiles of anatomy and physiology students using the Motivated Strategies for Learning Questionnaire (MSLQ). In addition, students were also asked an open-ended question about whether they thought their strategy use had changed because of the pivot to emergency remote teaching. Therefore, the research questions for this investigation were:

1) What were the MSLQ profiles of students at the beginning of emergency remote teaching?
2) What were the correlations between MSLQ scores and academic achievement while undertaking emergency remote teaching?
3) What were students' perceptions of the impact of the shift to emergency remote learning on their study strategies?
4) Did students believe that the shift to emergency remote teaching changed their use of self-regulated learning strategies and how did their perceptions of this change affect their MSLQ profile?

8.3. Method

8.3.1. Participants and Settings

The current study used a cohort observational design. The cohort included all first-year students studying anatomy and physiology at a regional Australian university at the onset of emergency remote teaching. Anatomy and physiology subjects are core to nursing and allied health programs (occupational therapy, physiotherapy, sports and exercise science, speech pathology) at the university. Students were recruited via a written notice containing the link to the questionnaire, posted on the learning management system for each subject. The timeline of events was as follows:

1. University announces “pause” week on March 18. All on-campus teaching suspended for the week 23 to 27 March [week 5 of 13 week semester] to allow academics time to “fast-track the development of online course materials and for the University to be made ready to implement additional social distance measures” (James Cook University, 2020)
2. Commence emergency remote teaching from 30 March
3. Final date for withdrawal without financial cost (Census Date) extended from 26 March to 14 April as part of the Academic Safety Net (Lloyd et al., 2021)
4. Questionnaire opened after Census Date to reduce the number of responses that could not be matched to final grade and ensure that students had experience with emergency remote teaching.

Students were recruited to the study via a written notice containing the link to the online questionnaire, posted on the learning management system for each subject. A total 432 students were enrolled at the time the questionnaire opened. A response rate of 12.5% was achieved, with 54 students completing the questionnaire between 21 April and 14 May 2020. Although this is a low response rate, it was not unexpected due to the stressful nature of the time and the large number of student surveys being deployed by the university (Field, 2020).

8.3.2. Instrument and Data Collection

The Motivated Strategies for Learning Questionnaire (MSLQ) contains 81 items in 15 subscales (Pintrich et al., 1991). The beginning of the questionnaire asked students to report demographic information including age, gender, and whether the student was the first in family to attend university, had previous experience in a higher education setting, their study load and which anatomy and physiology subject they were enrolled in. Students were also asked to estimate how much time they planned to spend studying each week for this subject, and how much time they would spend in paid employment, each week. Finally, the grades achieved by the students for the anatomy and physiology subject were included at the end of the semester. Students who achieved a grade of HD or D were considered to be higher achieving, while those who achieved a P or N were considered to be lower achieving.

Two additional questions concerning the transition to emergency remote teaching due to COVID-19 lockdowns:

1. "Do you feel that your approach to studying, or the strategies that you use to study your anatomy and physiology subject have changed as a result of the transition to remote and online learning?" Y/N
2. "Please provide some comment on how your studying strategies have changed/or remained the same following the transition to remote and online learning." – Open-ended

8.3.3. Data Analysis

Data were analysed using SPSS Version 28. Shapiro-Wilks' test of normality was carried out for each MSLQ subscale. Not all assumptions were met, therefore, non-parametric tests were used. Kruskal-Wallis tests were used to analyse the effect of demographic factors on the MSLQ subscales. Mann-Whitney U tests were used to compare the MSLQ subscales of participants with positive and negative comments. Both the p-value and the Hedge's g value are reported for this comparison. Hedge's g was chosen as the measure of effect size because the two groups were not equal. In addition, a Spearman's rank correlation analysis was carried out between the final mark achieved by the participants and their MSLQ subscale scores.

Cronbach's alpha was calculated for each subscale (Appendix D). Most were comparable to the results reported by Pintrich et al. (1991) and within acceptable limits. However, the extrinsic motivation subscale was below an acceptable level (0.448), and the peer learning subscale (0.586) was considerably lower than in the original investigation (0.76) by Pintrich et al. (1991).

Responses to the open-ended questions were thematically analysed using a semantic inductive approach and the six-phase recommended by Braun & Clarke (2006). Semantic analysis looks at the literal meaning of the responses, without any latent interpretation, while inductive coding does not rely on a pre-determined theoretical framework (Braun & Clarke, 2022). Responses were generally very short; therefore, more complex analysis could not be undertaken. Participants wrote between 3 and 129 words and the median was 25 words.

8.3.4. Ethics Approval

This study was part of a larger study that has been granted Human ethics approval by the University Human Research Ethics Committee (approval number H7611). Full information outlining the investigation and noting that data would be matched between questionnaires and with final grade was provided to students to allow them to make an informed decision regarding consent. Only students who consented progressed to the next page of the online questionnaire.

8.4. Results

8.4.1. Demographics

The majority of participants were school-leavers (66.7%) aged 19 years and under and female (72.2%). This is similar to the overall cohort of students in first year anatomy and physiology subjects where 54.2% are aged 19 and under and 82.1% are female. Most students passed their respective anatomy and physiology subjects.

Table 8-1: Demographic information and end-of-semester results of the participants

Demographic	**Category**	**Count (%)** (n=54)	**Whole cohort (%)**
Age	19 and under	36 (66.7)	54.2
	20-24	9 (16.7)	27.4
	25-29	7 (12.9)	7.6
	30+	2 (3.7)	10.6
Gender	Male	9 (16.7)	17.9
	Female	39 (72.2)	82.1
	Did not answer	6 (11.1)	-
Bachelor Program	Nursing	17 (31.5)	47.9
	Biomedicine	15 (27.8)	12.5
	Occupational Therapy	9 (16.7)	10.5
	Physiotherapy	9 (16.7)	18.3
	Speech Pathology	5 (9.3)	5.3
	Pharmacy	3 (5.6)	5.5
Study Load	1 subject	1 (1.9)	
	2 subjects	3 (5.6)	
	3 subjects	2 (3.7)	
	4 subjects (full-time)	48 (88.9)	
Final Grade[1]	HD >85%	13 (24.1)	
	D >75% and <85%	17 (31.5)	
	C >65% and <75%	14 (25.9)	
	P >50% and <65%	7 (12.9)	
	N <50%	1 (1.9)	
	Unknown[2]	2 (5.6)	

Note. [1] HD = High Distinction, D = Distinction, C = Credit, P = Pass, N = Not satisfactory. [2]Final grade for two participants is unknown, which may be due to an error with their student number or having withdrawn from the subject prior to completion.

Table 8-2: Hours of independent study reported by participants

Study Hours	Count (%) n=54
<4	10 (18.5)
4-6	26 (48.1)
7-10	9 (16.7)
11-20	6 (11.1)
>20	3 (5.6)

Kruskal-Wallis tests of the effect of each of the demographic items shown in Table 8-1 on the MSLQ scores showed no significant differences. In addition, analysis of the effect of hours spent studying (Table 8-2) also showed no significant difference, except in the effect regulation subscale, where those reporting less than 4 hours of study per week also reported lower effort regulation scores (3.9) than all other groups (5.5).

8.4.2. MSLQ Scores at the Beginning of Lockdown

Participants extrinsic motivation was higher than their intrinsic motivation. Overall, their task value for their bioscience subject was still quite high at the beginning of lock-down (6.2 ±0.716), and their self-efficacy was moderate (4.5 ±1.289). Participants reported the highest use of elaboration cognitive strategies (5.1 ±1.147) and the lowest use of critical thinking strategies (3.4 ±1.054). Reported use of metacognitive strategies and resource management strategies was moderate to high.

Table 8-3: Measures of self-regulated learning of bioscience students at the beginning of COVID-19 lockdown

MSLQ	Subscale	Mean	SD
Motivation	Intrinsic	4.9	1.178
	Extrinsic	5.5	0.940
	Task value	6.2	0.716
	Control of Learning Beliefs	5.6	1.038
	Self-Efficacy for Learning	4.5	1.289
	Test anxiety	5.0	1.666
Cognitive strategies	Rehearsal	4.8	1.238
	Elaboration	5.1	1.147
	Organisation	4.9	1.320
	Peer learning	4.2	1.384
	Critical thinking	3.4	1.054
Metacognitive strategies	Metacognitive Self-regulation	4.6	0.982
	Effort regulation	5.2	1.203
Resource Management	Environment	5.2	1.197
	Help seeking	4.0	1.247

Note. MSLQ Scale: 1= not at all true of me to 7= very true of me

8.4.3. Correlation Between Final Achievement and MSLQ Scores

Significant weak to moderate positive correlations were found between final mark in their bioscience subject and all of the motivation subscales except extrinsic goal orientation. Self-efficacy had the highest correlation (ρ=0.589, $p<0.001$), followed by task value (ρ=0.422, p=0.002). There was a moderate negative correlation between test anxiety and achievement (ρ=-0.402, p=0.003).

Elaboration was the only subscale with a significant positive correlation with achievement (ρ=0.303, p=0.029). This subscale also had the highest mean (5.1 ±1.147). There were significant weak-moderate positive correlations between achievement and metacognitive self-regulation (ρ=0.478, $p<0.001$), effort regulation (ρ=0.533, $p<0.001$) and time and environment management (ρ0.553, $p<0.001$).

Table 8-4: Spearman Rank Correlation of MSLQ subscales with final mark

MSLQ	Subscale	Spearman's rho (ρ)[1]	p	lower 95% CI	upper 95% CI
Motivation	Intrinsic	0.328	0.018	0.052	0.557
	Extrinsic	0.076	0.594	-0.209	0.349
	Task Value	0.422	0.002	0.160	0.628
	Control of Learning Beliefs	0.343	0.013	0.069	0.569
	Self-Efficacy for Learning	0.589	<0.001	0.370	0.746
	Test Anxiety	-0.402	0.003	-0.613	-0.137
Cognitive strategies	Rehearsal	0.159	0.261	-0.128	0.420
	Elaboration	0.303	0.029	0.025	0.538
	Organisation	0.188	0.183	-0.098	0.445
	Peer Learning	-0.099	0.483	-0.370	0.186
	Critical Thinking	-0.055	0.699	-0.330	0.229
Metacognitive strategies	Metacognitive Self-regulation	0.478	<0.001	0.229	0.669
	Effort regulation	0.533	<0.001	0.297	0.708
Resource Management	Environment	0.553	<0.001	0.323	0.722
	Help seeking	0.227	0.106	-0.057	0.477

Note. [1]Interpretation of correlation size (ρ): <0.3 = negligible 0.3-0.5 = weak, 0.5-0.7 = moderate, 0.7-0.9= strong

8.4.4. Student Perceptions of the Effect of Emergency Remote Teaching on Learning Strategy Use

In response to the Yes/No question, 81.5% of participants indicated that they felt that their approach to studying, or their use of study strategies had changed in response to emergency remote teaching, with the remaining 18.5% indicating that they felt it had not. Participants were then asked to elaborate on how things may have changed. The initial analysis of the responses to the open-ended question identified two distinct participant outlooks: a positive one (48.1% of participants), where participants described either making the best of the situation or finding new and more effective study strategies; and a negative one (44.4%), where participants described factors that had negatively impacted them and their studies.

The open-ended question was more informative than the yes/no question. Eight of the 10 participants who selected "No" were classified as having a positive outlook on the transition based on their comments. For example, *"My strategies have stayed the same. If anything, the collaborative environment for [subject] lectures has improved my understanding of content because we can ask questions and more actively follow along".*

There were only four participants who could not be assigned to either a positive or negative outlook. Two answered "No" to the first question and their comments were brief e.g., *"have* *remained the same"*; *"they did not"*. Two answered "Yes", then commented "*study has remained the same during the transition*"; "*study whenever rather than at specific times*".

Qualitative Findings. Thematic analysis of the open-ended questions found that participants described either positive or negative changes to their learning strategies following the move to emergency remote teaching. A minority of students felt that there was no change to their study strategies. Figure 8-1 shows the coding tree for the thematic analysis. There were some aspects of the face-to-face learning experience that were reported as being missed by participants, regardless of their overall positive or negative outlook on the changes to their study strategies.

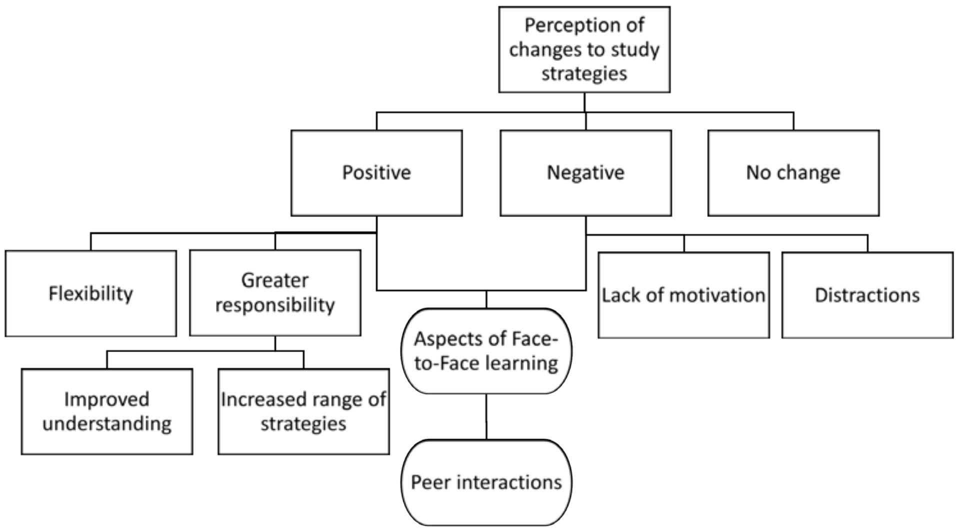

Figure 8-1: Coding tree for thematic analysis of participant comments about changes to study strategies after moving to emergency remote teaching

Positive outlook themes. Positive comments included words or phrases with positive connotations, such as "more engaged", "understand it better", "can spend longer", and "more effective". The predominant positive themes were increased flexibility, using more resources to improve understanding, and taking greater responsibility for their own learning.

"Not being able to be in the physical labs doing pracs has made me be more engaged with other resources outside of what is provided to fully understand certain aspects of content, e.g., watching videos about heart anatomy to understand what real hearts look like rather than just diagrams or simulations."

"I understand it better, having no distractions! I think next semester I will be doing uni online"

"Can spend longer in the lecture videos pausing and understanding the content, don't have to write the lecture slides down beforehand as the video for online lectures can be paused."

"I think I found more effective learning strategies for [subject] after the transition to online learning."

"I have forced myself to study more now that I am more responsible for my own learning and understanding. I am relying more on textbooks and other resources to broaden and expand on my understanding."

Negative outlook themes. Negative comments included words or phrases that had negative connotations, such as "really bad", more distractions, "hard", "less enjoyable". The predominant negative themes were lack of motivation, more distractions and missing peer interactions.

"For me, it's really hard to concentrate and focus on studying. Doesn't matter even if I put my phone away, as soon as I start studying random things come to my mind and take my attention away. Being at uni meant, I at least picked up random stuff from the lectures. But I have realised that my study is getting really bad. … I'm stressed out!"

"Moved back home with family so extra family chores and more people around to distract therefore study is conducted predominantly at night when others are asleep."

"Due to moving back home being surrounded by family and siblings I find it very hard to keep concentration and motivation. I miss lectures as they were a routine."

"I find it less enjoyable than [before] and I am less motivated to study as I find it requires more effort than what it does now as my study environments have changed. I used to always study in groups or with other people which I found beneficial for me but now it is difficult to do so since my study group have all moved off college and live in remote places."

8.5. Differences in MSLQ scores between participants with positive and negative outlooks.

Participants who described positive changes to their study strategies that occurred with the shift to emergency remote teaching reported significantly higher scores on metacognitive and resource management strategies (Table 8-5). They also had higher self-efficacy (4.9 ±1.16, p=0.021, g=0.602) and lower test anxiety (4.5 ±1.75, p=0.012, g=0.766). There were no statistically significant differences in reported use of the cognitive learning strategies. Those with a positive outlook achieved a slightly higher final mark, which was statistically significant (p=0.033) and had a moderate effect size (g=0.610); however, the standard deviations for both groups were quite high (SD=10.29 & SD=11.34) and the means were both above 70%.

Table 8-5: Mann-Whitney U test comparing MSLQ scores of participants with positive and negative outlook related to emergency remote teaching

MSLQ	Subscale	Negative n=24		Positive n=26		U	p	Hedge's g[1]
		Mean	SD	Mean	SD			
	Final mark	72.68	10.29	79.41	11.34	390.5	0.033	0.610
Motivation	Intrinsic	4.9	1.26	4.9	1.09	297.5	0.778	0.028
	Extrinsic	5.3	1.03	5.7	0.86	356.0	0.391	0.290
	Self-efficacy for Learning	4.1	1.18	4.9	1.16	431.0	0.021	0.602
	Control of learning beliefs	5.7	1.02	5.7	0.96	310.0	0.969	0.008
	Task value	6.2	0.75	6.4	0.67	348.5	0.475	0.228
	Test anxiety	5.7	1.33	4.5	1.75	182.5	0.012	0.766
Cognitive strategies	Rehearsal	4.6	1.23	5.1	1.16	377.0	0.206	0.374
	Elaboration	4.8	1.25	5.3	1.02	375.0	0.220	0.376
	Organisation	4.8	1.57	5.1	1.14	332.5	0.690	0.183
	Critical thinking	3.4	1.07	3.6	1.05	310.5	0.977	0.119
	Peer Learning	4.4	1.48	3.9	1.36	257.0	0.284	0.325
Metacognitive strategies	Metacognitive self-regulation	4.2	1.01	5.0	0.82	450.5	0.007	0.825
	Effort regulation	4.7	1.38	5.7	0.84	438.5	0.014	0.833
Resource Management	Time & environment	4.7	1.33	5.6	0.95	441.0	0.012	0.778
	Help seeking	3.9	1.38	4.2	1.07	341.5	0.566	0.214

Note. Four students who could not be allocated to either positive or negative outlook were excluded from this analysis. [1]Hedge's g interpretation: 0.2 = weak effect, 0.5 = moderate effect, 0.8 = large effect. SD = standard deviation.

8.6. Discussion

The current investigation has some parallels with research investigating students' perceptions and achievement in altered learning environments that are contrary to the students' initial expectations of higher education. For example, Wiley (1983) investigated nursing students' performance and change in self-directed readiness scores after undertaking a trial self-directed learning project. They found that some students lost points on the readiness score following the project and suggested that it could be due to students' being annoyed by the learning environment. There are similar reports when shifting to active learning (Al-Modhefer & Roe, 2009; Owens et al., 2020). Indeed, the students in this study were not participating in the type of learning environment that they thought they would be. In addition, the global pandemic added a great deal of general uncertainty and anxiety (Haikalis et al., 2022; McWatt, 2021).

The types of comments given by the participants in this study about the impact of emergency remote teaching on their motivation and their use of various learning strategies were consistent with those reported by other researchers (e.g., Biwer et al., 2021; McKay et al., 2021; McWatt, 2021) and an Australian Government report on student experience during the pandemic

(Martin, 2020). Most studies found that some students reported improvement in their self-regulation, strategy use and even understanding of the content, while other students were negatively affected by distractions and motivation, particularly those students in rural and regional universities in Australia (Martin, 2020). Martin (2020) reported that about one third of all responses mentioned lack of sufficient peer interaction, with a further 15% reported feelings of isolation, that were not alleviated by the use of collaborative software. Participants of the current study also reported that they missed peer interactions, regardless of their outlook. Peer learning has become an important part of education in science related domains such as bioscience. In this university, and others (McWatt, 2021), there is usually a laboratory component to anatomy and physiology subjects where students can interact informally to co-construct their understanding of the content.

There were statistically significant differences between students with a positive outlook and those with a negative outlook in five of the fifteen MSLQ subscales: self-efficacy and test anxiety, metacognitive self-regulation, effort regulation, time and study environment. Self-efficacy is the perception that one is able to undertake a particular task (Bandura, 1997). Self-efficacy for learning the subject content is regularly associated with high academic achievement (Honicke & Broadbent, 2016; Schunk & Dibenedetto, 2018). In the current investigation, students with high self-efficacy also had a more positive outlook on the changes to their study strategies caused by the transition to emergency remote teaching. They also scored higher on MSLQ subscales measuring the use of strategies associated with planning and managing their learning, and effort regulation and their comments reflected using these strategies. Honicke and Broadbent (2016) report that effort regulation is a partial mediator between self-efficacy and academic achievement: those students with high self-efficacy are more likely to better regulate their effort, leading to higher achievement.

The same five MSLQ subscales were among those weakly to moderately positively correlated to the final mark achieved by the participants (except for test anxiety which was negatively correlated). Therefore, higher achieving students in this study reported higher use of metacognitive and resource management strategies, regardless of their outlook. Reviews and meta-analyses of the MSLQ have shown that metacognitive and resource management strategies often have the strongest correlation with achievement (Credé & Phillips, 2011; Richardson et al., 2012)

Furthermore, an additional three motivation subscales were weakly positive correlated to final grade: intrinsic goal orientation, task value and control of learning beliefs. Only one cognitive scale was correlated with final mark, and that was elaboration. Elaboration strategies are useful for making connections between concepts and with prior knowledge, making them strategies that foster deeper understanding of the material. According to Weinstein et al. (2010) the benefits of elaboration strategies come from the active processing and transformation of information. Honicke and Broadbent (2016) found that deep processing learning strategies such as elaboration are mediators of the relationship between self-efficacy and academic achievement.

8.7. Conclusion

Scores from some of the subscales of the MSLQ at the beginning of lockdown were predictive of final mark. Therefore, this may be a useful questionnaire to implement in the event of future disruptive events to help direct students to appropriate assistance. One disadvantage of the questionnaire is its length, therefore, it would be advisable to use a shortened version, leaving out subscales that have less predictive value, such as extrinsic goal orientation, and some of the cognitive learning strategies such as peer learning and rehearsal. Pintrich et al. (1991) have noted that the subscales can stand alone, therefore, the integrity and validity of the questionnaire is not compromised by electing not to use all subscales.

It would also be advisable to ensure that students have adequate declarative, procedural and conditional knowledge to implement a range of metacognitive self-regulation strategies, resource management strategies and elaborative cognitive learning strategies. It is likely too late to implement this type of intervention once a disruptive event has occurred, because of the increased anxiety. The development and delivery of a meta-curriculum (Weinstein, 1982), where learning strategy instruction is incorporated with the content area, would be a beneficial method of instruction to support students' experience with a range of cognitive, metacognitive and resource management strategies.

9. Chapter 9: General Discussion

9.1. Introduction

The aim of this research was to investigate the phenomenon known in the nursing education literature as the 'bioscience problem' and to develop an educational intervention to foster student achievement in bioscience subjects. The term 'bioscience problem' was coined by McVicar et al. (2014) to encompass a range of difficulties nursing students have with the core bioscience subjects within their nursing programs. Difficulties reported in the literature include that nursing students perceive the biosciences as more difficult than other subjects within nursing programs, and that students academically underachieve in biosciences (Jensen et al., 2018; McVicar et al., 2014, 2015). In addition, difficulties with biosciences can lead to attrition from nursing programs (McVicar et al., 2014) and problems with integrating bioscience knowledge into clinical practice (Birks et al., 2018; Molesworth & Lewitt, 2016).

The literature has been reporting the 'bioscience problem' since the 1990s (Caon & Treagust, 1993). Early research investigating the 'bioscience problem' reported that nursing students had low self-efficacy for bioscience, and that they may have a limited repertoire of learning strategies for encoding and understanding the content (Andrew & Vialle, 1998; Salamonson et al., 2009).

At the same time, there was a push from accrediting bodies to use self-directed learning theory as the predominant teaching method within nursing pre-registration programs, and professional development programs (Nolan & Nolan, 1997a; Wiley, 1983). Self-directed learning theory was embraced by nursing pre-registration programs as a cure to rote learning and low academic achievement (Nolan & Nolan, 1997a) and to develop nursing professionals who would have the skills to remain current once accredited. Self-directed learning as an instructional method involves students taking responsibility and initiative in "diagnosing their learning needs, formulating goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies and evaluating outcomes" (Knowles, 1975, p. 18).

However, there was some criticism of the widespread adoption of self-directed learning (Darbyshire, 1993; Nolan & Nolan, 1997a), particularly in regard to assumptions that all adults are both motivated and able to take initiative, and that they prefer to take responsibility of their learning. Studies comparing nursing students to other students found that nursing students tend to prefer a greater amount of structure (Boström & Hallin, 2012; Salamonson et al., 2009; Turunen et al., 1997). Other studies found that nursing students were not ready for self-directed learning (Barker et al., 2016; O'Shea, 2003; Slater & Cusick, 2017; Timmins, 2008).

In contrast to self-directed learning, self-regulated learning theory focusses on what students do to achieve their learning goals. Thus, it emphasises both the skills and strategies employed by the student to encode the information and remember it; as well as the cyclical process of task analysis and goal setting, self-monitoring performance against goals, and making necessary adjustments. A student with self-regulated learning skills will be able to self-direct their learning (Loyens et al., 2008; Saks & Leijen, 2014). In addition, the use of self-regulated learning strategies has been repeatedly empirically correlated with higher academic achievement (Honicke & Broadbent, 2016; Richardson et al., 2012; Zimmerman, 2001).

In two reviews of the 'bioscience problem', McVicar et al. (2014, 2015) made several recommendations to improve academic achievement. The first recommendation was to increase the tertiary entrance requirements by increasing the entrance score and adding high school science as pre-requisites. While these measures have the potential to decrease attrition from programs, they will reduce the number of applicants that can be admitted. This may be counter to Australian and global initiatives to widen participation in higher education (Bradley et al., 2008; Pitman, 2017; UNESCO, 2022). In addition, some countries are experiencing shortages in their nursing workforce, and decreasing the number of potential graduates may contribute to future shortages (Beauvais et al., 2014; Olsen, 2017). Furthermore, many universities in Australia are abandoning science pre-requisites to some tertiary programs (Finkel et al., 2020) and are therefore, unlikely to introduce them for nursing programs.

The other recommendations from McVicar et al. (2014, 2015) were to increase student self-efficacy for biosciences during the transition to university and to support and increase students' study skills. I believe that these recommendations can be achieved by training students in the use of the cognitive, metacognitive and resource management strategies associated with self-regulated learning, specifically within the context of their bioscience subjects.

Within self-regulated learning literature, the most commonly used method or instrument to measure students' academic motivations and learning strategy use is the Motivated Strategies for Learning Questionnaire (MSLQ) (Panadero, 2017; Roth et al., 2015). Therefore, the MSLQ was used in the current investigation to measure student motivations towards biosciences, and their use of cognitive, metacognitive and resource management learning strategies in pursuit of their learning goals within the biosciences. The MSLQ consists of 15 subscales divided into two sections. The motivation section contains 6 subscales and covers areas of student motivation for learning such as task value, intrinsic and extrinsic goal orientation, self-efficacy and control of learning beliefs. The learning strategies section contains 9 subscales covering a range of cognitive, metacognitive and resource management strategies. The subscales are reported on a 7-point Likert type scale.

This chapter draws together the results presented in this thesis and considers implications for bioscience education for nursing and allied health students.

9.2. Overview of Investigation

The first study piloted the use of the MSLQ with first-year students within the nursing and allied health programs at a regional university in a pre-post research design at the beginning and end of a one semester bioscience subject. The aim was to measure any change in the MSLQ subscales over the semester, without any adjustment to the curriculum. Additionally, changes in subscales were compared with academic achievement.

The second study developed and implemented a self-regulated learning strategy intervention within a diploma level foundation bioscience subject. Similarly, the MSLQ was deployed in a pre-post research design at the beginning and end of a single semester. The aim was to measure changes in the MSLQ subscales and note any correlations with academic achievement. The intervention participants were also invited for interview to gain insight into their perceptions of their learning strategy use following the intervention.

The third study was a single point measure using the MSLQ following the “pause week” at the beginning of the COVID-19 pivot to emergency remote teaching. In addition to the MSLQ, students were given an open-ended question about their use of learning strategies with the new delivery method.

9.3. Discussion

9.3.1. Motivation for learning

The motivation section of the MSLQ includes subscales for intrinsic and extrinsic goal orientations, control of learning beliefs, task value, self-efficacy, and test anxiety. Both diploma students and first-year students studying bioscience reported higher extrinsic goal orientation than intrinsic. This is consistent with other studies, which suggest that the main motivation to learn biosciences, for these students, is the goal of becoming a registered nurse or other accredited allied health practitioner (e.g., Nilsson & Warren Stomberg, 2008; Salamonson et al., 2009).

Task value scores were also consistently high across the three studies of the investigation and were correlated with academic achievement amongst the first-year students, but not the diploma students. In early literature speculating on the cause of the ‘bioscience problem’ it has been suggested that students may fail to see the relevance of bioscience to their future clinical practice

(Jordan et al., 1999). High task value scores reported in this investigation suggest that this is not the case. Rather, they tend to corroborate Whyte et al.'s (2011) observation that nursing students have a "love-hate relationship" with bioscience where, although they underachieve, they recognise the importance of the content. More recent research has found that nursing students rate the biosciences as highly relevant to their professional practice, particularly as they progress through their nursing programs (Barton et al., 2021; Betty & Una, 2016; Montayre et al., 2019).

Similarly, control of learning beliefs were also consistently high across the three studies of the investigation. In addition, this score had weak to moderate correlation with achievement for first year students, and for diploma students following the intervention. This is an interesting finding and deserves further investigation. Anecdotal discussions with participants suggested that they had a more external locus of control, whereby some of their success is dependent on what the instructor does. This was also noted in other studies of nursing students in self-directed learning scenarios, where students felt that academics were not doing their jobs appropriately (Timmins, 2008), and also in studies of first-year students more generally (Osgood Smith & Price, 1996). In addition, it has been noted in retrieval practice research, that students expect all revision questions to be provided by the instructors (Biwer et al., 2020) rather than attempting to develop them independently. It is possible that the control of learning beliefs subscale is not adequate to measure the weighting between internal and external loci of control because it focusses primarily on students' effort.

Attribution theory states that students will attempt to identify the cause of the success or failure to achieve their learning goal, and that factors could include things like ability, effort, context (the learning environment) or luck (Dunn, Osborne, et al., 2012). Some of these factors are internal and some are external (Osgood Smith & Price, 1996). Attribution of success or failure is part of the self-reflection phase of the cyclical model of self-regulation (Zimmerman & Moylan, 2009). It is also included in Pintrich's conceptual framework (Pintrich, 2004), however, the questions in the MSLQ for this subscale focus on student effort ('try hard enough' is in two of the four items), rather than offering alternatives like luck or contextual factors. In addition, 'try hard enough' may mean different things to different students, if it means 'spend more time', then many of the lower achieving students will select a higher number because they often report spending a larger number of hours on study each week.

In all studies in this investigation, self-efficacy for learning bioscience was a key factor correlated with student academic achievement. These findings are consistent with wider research linking self-efficacy and achievement (Honicke & Broadbent, 2016; Richardson et al., 2012; Robbins et al., 2004; Schneider & Preckel, 2017). Therefore, continuing to develop activities that improve student self-efficacy for learning the bioscience content is an important goal.

9.3.2. Cognitive learning strategies

Cognitive strategies are important for processing information to enhance understanding and for moving information to long term memory. The formation of these memories allows information to be retrieved to enhance critical thinking and decision making in clinical contexts. As noted by Shuell (1990) and Hattie and Donoghue (2016), different cognitive strategies are more effective at different points along the learning journey. At the beginning, when everything feels like disconnected facts, surface strategies like using flashcards for memorisation through repetition help to provide the base knowledge which will be integrated more fully further along the journey. Introductory level bioscience subjects like anatomy and physiology are very content heavy, there is a lot to know about the body that becomes background information for future, more applied subjects. Beginning students may grapple with making connections, particularly if it appears that surface level knowledge is valued by the assessment tasks given (Momsen et al., 2010; Sand-Jecklin, 2007; Siegesmund, 2017; Snelgrove, 2004). An important task for instructors is to facilitate students moving to the next point on the learning journey, where making connections between concepts and prior knowledge helps them to understand the facts, and to be able to use them.

For this to occur, students need a varied repertoire of cognitive strategies to process the information, and an understanding of metacognitively monitoring their comprehension. The current study disputes the assumption that adult learners have already internalised sufficient cognitive strategies (Hattie et al., 1996; Jansen et al., 2019). Intervention participants who were interviewed for the current study reported trying strategies that were new to them as a result of the intervention. This was also found in the study by Ainscough et al. (2020) which found that students were willing to try new strategies they found on student discussion boards. Therefore, these strategies were not part of their current repertoire.

Early cognitive strategy research by Weinstein and colleagues (1989; 1991) separated the cognitive learning strategies into rehearsal, elaboration and organisation strategies. Elaboration and organisation are deeper learning strategies requiring more effortful cognitive work. These classifications were included in the MSLQ. Within the context of the MSLQ, elaboration strategies are concerned with making connections between concepts and with prior knowledge, while the organisation strategies are predominantly concerned with organising main ideas. The use of elaboration strategies has been correlated with achievement (Honicke & Broadbent, 2016; Richardson et al., 2012). Within this research, there were correlations between elaboration strategies and achievement across all three studies. Therefore, these strategies should be included in any intervention. Weinstein (2010) notes that this a very diverse set of strategies, and also that it is not so much the strategy as the active thinking that is beneficial.

I have included peer learning as a cognitive strategy in this study because active thinking is required in the co-construction of meaning. However, it can also be conceived as help-seeking (and there is an item in the MSLQ that relates to this), and a method of self-evaluation, as was described by the participants in the current study. It is interesting that across all three studies of the investigation, student MSLQ reports of peer-learning were fairly low. In all the anatomy and physiology subjects included in the study, there is a weekly laboratory or practical class where students are expected to work through the activities in small groups. In addition, the reports from the interviewed participants contradict the low scores on the MSLQ subscale, by describing the extent that they used and relied on those small group activities to consolidate their understanding of the content.

The above cognitive learning strategies are all included in the MSLQ, which was developed in 1991. More contemporary research has shown the efficacy of strategies, such as retrieval practice and spaced repetition for the consolidation of memories. These learning strategies are now routinely recommended to students (Dunlosky et al., 2013). However, the use of these strategies is not detectable using the MSLQ. Despite this, retrieval practice was included in the intervention and used often throughout the semester. Interview participants indicated that they engaged in the retrieval practice activities regularly and that the activities helped with their understanding of the content. Kornell and Vaughn (2016) note that both successful and unsuccessful attempts to retrieve the correct information assist in moving information to long-term memory, as long as unsuccessful attempts are followed by feedback. In addition, Buchin and Mulligan (2022) found that testing-effect benefits were afforded regardless of the level of participants' prior-knowledge of the content. If the goal is deeper learning, then it may be important to produce retrieval practice questions that do not overly rely on surface level knowledge (Scully, 2017). An additional benefit of retrieval practice is that it provides information relevant to metacognitive self-evaluation of understanding that can be used by the student to plan future study sessions (Littrell-Baez et al., 2015).

Research has shown that the independent study strategies that student's use most often are usually the least effective, and that they tend to be passive strategies like re-reading. Students are very good at judging the difficulty of a strategy, but not the beneficial effect of the strategy, and often give up on strategies they find difficult (de Bruin et al., 2023). Therefore, including explicit instruction in other cognitive strategies into workshops or tutorials where students can ask questions, practice procedure and receive feedback is recommended to assist in increasing students' repertoire. The interview participants noted that some of the strategies were new to them, and that they needed more practice to be confident to perform them independently.

9.3.3. Metacognitive and resource management strategies

The metacognitive and resource management strategy scales of the MSLQ are often positively correlated to achievement (Richardson et al., 2012), particularly the metacognitive self-regulation subscale and the effort regulation subscale. There was quite a bit of variability in these subscales across the studies in the current investigation. There were weak to moderate correlations with achievement in studies 1 and 3, however, there were negligible correlations with the intervention group. One explanation for this, is that students across all levels were attempting to use the strategies but had not yet mastered them. A confounding factor may have been that the distinction level students were not fully engaged with the content or the learning strategy intervention due to the content being significantly below their zone of proximal development (Vygotsky, 1980).

In addition, although the metacognitive prompts were available to the students, they were not required to complete them. I believe that this was a weak spot in the intervention. To strengthen future metacognitive exercises, it would be beneficial to assign assessment weighting to those tasks, in a similar way to the meta-assessment tasks of Colthorpe colleagues (Colthorpe et al., 2017, 2019b).

9.3.4. A short evaluation of the MSLQ

The extensive review by Credé and Phillips (2011) reported that the many subscales of the MSLQ are quite variable in their ability to predict student achievement. They found moderate correlations between achievement and self-efficacy, elaboration, critical thinking and metacognitive self-regulation. Further, they illustrated that subscales with low correlations may have poorly worded items and could benefit from further develop. However, they concluded that the MSLQ is still a valuable tool.

It has been noted in other studies that the metacognitive self-regulation subscale of the MSLQ may not be an entirely valid measure (Crede & Phillips, 2011; Duncan & Mckeachie, 2005; Dunn, Lo, et al., 2012; Hilpert et al., 2013; Pintrich, 2004; Pintrich et al., 1991; Tock & Moxley, 2016). It was intended to measure three separate strategies (Tock & Moxley, 2016); however, it emerged as a single subscale. Therefore, it is not able to provide insight into strengths and weaknesses of students' strategy use. In addition, more recent research on effective study strategies such as retrieval practice and spaced repetition, have not be incorporated into the MSLQ (Dunlosky et al., 2013).

Some of the subscales of the MSLQ could be used at the beginning of a new unit of study in two ways. Firstly, to identify students likely to need support, or secondly, and as a metacognitive tool to engage students in understanding themselves as learners, and the varied learning strategies available to them. However, it was not as useful to understand what students are doing during their independent study time – especially when lower achieving students are reporting an excessive number of hours of study each week.

9.4. Limitations

The main limitations of this study is that it was conducted in a single regional university, with a relatively small sample size. As such, any generalisation of conclusions should be undertaken with caution. It would be beneficial to expand the investigation to include larger cohorts of students at other regional and urban universities.

9.5. Conclusion

This study has shown that the inclusion of explicit instruction in the use of self-regulated learning strategies within a foundation bioscience subject was practicable without compromising time on content. It has also shown promise in the development of student skills in the use of self-regulated learning strategies and skills within the bioscience context. Although there were minimal changes in the scores on the MSLQ over the semester, the direction of change was one of improvement in the use of the skills, particularly critical thinking. The difference between the MSLQ results and the interview transcripts suggests that the MSLQ is not adequate to measure the change in the use of the strategies over a single semester in this cohort of students. This could, however, be a function of the instrument, rather than a function of the intervention, as evidenced by the literature questioning the validity of the instrument. In addition, many of the studies where the MSLQ shows larger changes in scores across the semester are in extra-curricular “learning to learn” subjects where student participation may be greater due to the students electing to enrol (Montero et al., 2017; Pintrich et al., 1993; Steiner et al., 2019). Finally, the interview transcripts suggested that students may not be able to recognise the strategies they were using in the terms used in the MSLQ items. For future research, additional methods such as learning diaries or the meta-assessment tasks used by Colthorpe and Ainscough (e.g., Colthorpe et al., 2019a, 2019b) should be incorporated. The meta-assessment tasks show particular promise because they contribute to the students’ final grade.

The fact that the MSLQ score did not change as much as desired should not deter educational practitioners from undertaking the task of integrating the teaching of learning strategies with their content. Students need time and practice to develop these skills (Pintrich, 1999; Zimmerman & Moylan, 2009). A meta-curriculum such as this provides an opportunity for students of all abilities to engage with a range of learning strategies while also learning the content, skills and attitudes of the domain (Weinstein, 1982). In particular, it removes the burden from the student of having to seek additional learning strategy support when they are already very time-poor. Designing a meta-curriculum can take extra staff time, however, the description of the current intervention provides a starting point for educators. The description breaks down the steps and provides insight into the educational theories involved.

In addition, this study offers educators an alternative theory to support the development of skills students can use to be successful in self-directed learning and life-long learning, which are key components of careers in nursing and allied health fields. Self-regulated learning theory provides clear theoretical and practical guidance for the development of learning skills related to improved academic achievement.

9.6. Recommendations and future directions

The main focus of this study was the implementation of an intervention to support the development of study skills to enhance achievement in the biosciences for nursing and allied health students. In light of the positive trends in the data, and positive perceptions of the students, further refinement of the intervention should be undertaken. It would also be of benefit to undertake a longitudinal study to evaluate any differences in strategy use in future bioscience subjects between students who have been part of the intervention and those who have not because the internalisation and automation of these strategies takes effort and time.

- **Recommendation 1**: Continue to develop the intervention by refining metacognitive prompting.
- **Recommendation 2**: Extend the intervention into first year bioscience subjects for nursing and allied health students.
- **Recommendation 3**: Undertake longitudinal studies to understand students use of strategies in subsequent bioscience subjects, following their participation in an intervention.
- **Recommendation 4**: Use alternative methods for collecting the data, e.g., learning journals, or meta-assessment tasks to gain a better understanding of the strategies that students are consistently using to encode, remember and understand information.

References

Adams, N. E. (2015). Bloom's taxonomy of congnitive learning objectives. *Journal of the Medical Library Association*, *103*(July), 152–153. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4511057/

Aiken, L. H. (2003). Educational levels of hospital nurses and surgical patient mortality. *JAMA: The Journal of the American Medical Association*, *290*(12), 1617–1623. https://doi.org/10.1001/jama.290.12.1617

Aiken, L. H., Sloane, D. M., Bruyneel, L., Heede, K. Van Den, Griffi, P., Busse, R., Diomidous, M., Kinnunen, J., Kózka, M., Lesaff, E., Mchugh, M. D., Marie, A., Schwendimann, R., & Scott, P. A. (2014). Nurse staffing and education and hospital mortality in nine European countries : a retrospective observational study. *Lancet*, *383*, 1824–1830. https://doi.org/10.1016/S0140-6736(13)62631-8

Ainscough, L., Leung, R., & Colthorpe, K. (2020). Learning how to learn: Can embedded discussion boards help first-year students discover new learning strategies? *Advances in Physiology Education*, *44*(1), 1–8. https://doi.org/10.1152/advan.00065.2019

al-Modhefer, A. K., & Roe, S. M. (2010). Tutorials for large classes of Common Foundation Program biomedical science students: successes and challenges. *Nurse Education Today*, *30*(4), 365–369. https://doi.org/10.1016/j.nedt.2009.09.009

Al-Modhefer, A. K., & Roe, S. M. (2009). Nursing students' attitudes to biomedical science lectures. *Nursing Standard*, *24*(14), 42–48. https://doi.org/10.7748/ns.24.14.42.s47

Anderson, D. K., Schoenleber, M., & Korshavn, S. (2023). Higher-order clicker questions engage students and prepare them for higher-order thinking activities. *Journal of Microbiology & Biology Education*, *7*. https://doi.org/10.1128/jmbe.00151-22

Anderson, L., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives.* (L. Anderson, D. R. Krathwohl, P. Airasian, K. A. Cruikshank, R. E. Mayer, P. R. Pintrich, J. Raths, & M. C. Wittrock (eds.); Abridged). Longman. https://www.uky.edu/~rsand1/china2018/texts/Anderson-Krathwohl - A taxonomy for learning teaching and assessing.pdf

Andrew, S., McVicar, A., Zanganeh, M., & Henderson, N. (2015). Self-efficacy and relevance of bioscience for nursing, midwifery and healthcare students. *Journal of Clinical Nursing*, *24*(19–20), 2965–2972. https://doi.org/10.1111/jocn.12933

Andrew, S., & Vialle, W. (1998). Nursing students' self-efficacy, self-regulated learning and academic performance in science. *Nursing Times*, *76*(10), 427–432. https://www.aare.edu.au/data/publications/1998/and98319.pdf

Ariel, R., & Karpicke, J. D. (2018). Improving self-regulated learning with a retrieval practice intervention. *Journal of Experimental Psychology: Applied*, *24*(1), 43–56. https://doi.org/10.1037/xap0000133

Bakon, S., Craft, J., Christensen, M., & Wirihana, L. (2016). Can active learning principles be applied to the bioscience assessments of nursing students? A review of the literature. *Nurse Education Today*, *37*, 123–127. https://doi.org/10.1016/j.nedt.2015.11.030

Bandura, A. (1977). *Social Learning Theory*. Prentice Hall. https://www.asecib.ase.ro/mps/Bandura_SocialLearningTheory.pdf

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, *37*(2), 122–147.

Bandura, A. (1986). *Social foundations of thought and action: A social cogntive theory*. Prentice-Hall, Inc.

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behaviour and Human Decision Processes*, 248–287. https://doi.org/10.1016/0749-5978(91)90022-L

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117–148. https://doi.org/10.1207/s15326985ep2802_3

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.

Bandura, A. (2001). Social cognitive theory : An agentic perspective. *Annual Review Of Psychology*, *52*, 1–26. https://doi.org/https://doi.org/10.1146/annurev.psych.52.1.1

Bandura, A. (2012). Social cognitive theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of Theories of Social Psychology: Volume 1* (pp. 349–374). SAGE Publications Ltd. https://doi.org/10.4135/9781446249215.n18

Barker, C., King, N., Snowden, M., & Ousey, K. (2016). Study time within pre-registration nurse education: A critical review of the literature. *Nurse Education Today*, *41*, 17–23. https://doi.org/10.1016/j.nedt.2016.03.019

Bartimote-Aufflick, K., Bridgeman, A., Walker, R. A., Smith, L., Bridgeman, A., Walker, R. A., Sharma, M., & Smith, L. (2016). The study , evaluation , and improvement of university student self-efficacy. *Studies in Higher Education*, *41*(11), 1918–1942. https://doi.org/10.1080/03075079.2014.999319

Barton, M. J., Bentley, S., Craft, J., Dupen, O., Gordon, C. J., Cayanan, E. A., Kunst, E., Connors, A., Todorovic, M., & Johnston, A. N. B. (2021). Nursing students' perceptions of clinical relevance and engagement with bioscience education: A cross-sectional study of undergraduate and postgraduate nursing students. *Nurse Education Today*, *99*(May 2020), 104767. https://doi.org/10.1016/j.nedt.2021.104767

Beauvais, A. M., Stewart, J. G., DeNisco, S., & Beauvais, J. E. (2014). Factors related to academic success among nursing students: A descriptive correlational research study. *Nurse Education Today*, *34*(6), 918–923. https://doi.org/10.1016/j.nedt.2013.12.005

Bengtsson, M., & Ohlsson, B. (2010). The nursing and medical students motivation to attain knowledge. *Nurse Education Today*, *30*(2), 150–156. https://doi.org/10.1016/j.nedt.2009.07.005

Betty, R., & Una, K. (2016). Final year nursing students self-reported understanding of the relevance of bioscience. *International Journal of Nursing and Midwifery*, *8*(5), 35–46. https://doi.org/10.5897/IJNM2016.0208

Biggs, J. (1993). What do inventories of students' learning processes really measure? A theoretical review and clarification. *British Journal of Educational Psychology*, *63*(1), 3–19. https://doi.org/10.1111/j.2044-8279.1993.tb01038.x

Bingen, H. M., Steindal, S. A., Krumsvik, R., & Tveit, B. (2019). Nursing students studying physiology within a flipped classroom, self-regulation and off-campus activities. *Nurse Education in Practice*, *35*, 55–62. https://doi.org/10.1016/j.nepr.2019.01.004

Birks, M., Chapman, Y., Ralph, N., McPherson, C., Eliot, M., & Coyle, M. (2013). Undergraduate nursing studies: The first-year experience. In *Journal of Institutional Research* (Vol. 18, Issue 1). https://files.eric.ed.gov/fulltext/EJ1094101.pdf

Birks, M., Davis, J., Smithson, J., & Cant, R. (2016). Registered nurse scope of practice in Australia: an integrative review of the literature. *Contemporary Nurse*, *52*(5), 522–543. https://doi.org/10.1080/10376178.2016.1238773

Birks, M., Ralph, N., Cant, R., Chun Tie, Y., & Hillman, E. (2018). Science knowledge needed for nursing practice: A cross-sectional survey of Australian registered nurses. *Collegian*, *25*(2), 209–215. https://doi.org/10.1016/j.colegn.2017.05.005

Biwer, F., oude Egbrink, M., Aalten, P., & de Bruin, A. B. H. (2020). Fostering effective learning strategies in Higher Education – A mixed-methods study. *Journal of Applied Research in Memory and Cognition*, *9*(2), 186–203. https://doi.org/10.1016/j.jarmac.2020.03.004

Biwer, F., Wiradhany, W., oude Egbrink, M., Hospers, H., Wasenitz, S., Jansen, W., & de Bruin, A. (2021). Changes and adaptations: How university students self-regulate their online learning during the COVID-19 pandemic. *Frontiers in Psychology*, *12*(April), 1–12. https://doi.org/10.3389/fpsyg.2021.642593

Blasiman, R. N., Dunlosky, J., & Rawson, K. A. (2017). The what, how much, and when of study strategies: comparing intended versus actual study behaviour. *Memory*, *25*(6), 784–792. https://doi.org/10.1080/09658211.2016.1221974

Blegen, M. A., Goode, C. J., Park, S. H., Vaughn, T., & Spetz, J. (2013). Baccalaureate education in nursing and patient outcomes. *Journal of Nursing Administration*, *43*(2), 89–94. https://doi.org/10.1097/NNA.0b013e31827f2028

Boekaerts, M. (1997). Self-regulated learning: A new concept embraced by researchers, policy makers, educators, teachers, and students. *Learning and Instruction*, *7*(2), 161–186. https://doi.org/10.1016/S0959-4752(96)00015-1

Boström, L., & Hallin, K. (2012). Learning style differences between nursing and teaching students in Sweden: A comparative study. *International Journal of Higher Education*, *2*(1). https://doi.org/10.5430/ijhe.v2n1p22

Bradley, D., Noonan, P., Nugent, H., & Scales, B. (2008). *Review of Australian Higher Education* (Issue December). www.deewr.gov.au/he_review_finalreport

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2022). *Thematic analysis: A practical guide*. SAGE.

Breytenbach, C., Ten Ham-Baloyi, W., & Jordan, P. J. (2017). An integrative literature review of evidence-based teaching strategies for nurse educators. *Nursing Education Perspectives*, *38*(4), 193–197. https://doi.org/10.1097/01.NEP.0000000000000181

Briggs, A. R. J., Clark, J., & Hall, I. (2012). Building bridges: Understanding student transition to university. *Quality in Higher Education*, *18*(1), 3–21. https://doi.org/10.1080/13538322.2011.614468

Brown, S. J., White, S., & Power, N. (2017). Introductory anatomy and physiology in an undergraduate nursing curriculum. *Advances in Physiology Education*, *41*(1), 56–61. https://doi.org/10.1152/advan.00112.2016

Buchin, Z. L., & Mulligan, N. W. (2022). Retrieval-Based Learning and Prior Knowledge. *Journal of Educational Psychology*, *115*(1), 22–35. https://doi.org/10.1037/edu0000773

Butterfield, B., & Metcalfe, J. (2001). Errors committed with high confidence are hypercorrected. *Journal of Experimental Psychology: Learning Memory and Cognition*, *27*(6), 1491–1494. https://doi.org/10.1037/0278-7393.27.6.1491

Butzlaff, A., Gaylle, D., & O'Leary Kelley, C. (2018). Student self-evaluation after nursing examinations: That's a wrap. *Nurse Educator*, *43*(4), 187–190. https://doi.org/10.1097/NNE.0000000000000534

Cadorin, L., Bressan, V., & Palese, A. (2017). Instruments evaluating the self-directed learning abilities among nursing students and nurses: A systematic review of psychometric properties. *BMC Medical Education*, *17*(1), 1–13. https://doi.org/10.1186/s12909-017-1072-3

Candy, P. C. (1991). *Self-direction for lifelong learning. A comprehensive guide to theory and practice.* Jossey Bass Inc.

Cao, L., & Nietfeld, J. L. (2007). College students' metacognitive awareness of difficulties in learning the class content does not automatically lead to adjustment of study strategies. *Australian Journal of Educational and Developmental Psychology*, *7*, 31–46. https://files.eric.ed.gov/fulltext/EJ815620.pdf

Caon, M., & Treagust, D. (1993). Why do some nursing students find their science courses difficult? *Journal of Nursing Education*, *32*(6), 255–259. https://doi.org/10.3928/0148-4834-19930601-07

Cazan, A. M. (2022). An intervention study for the development of self-regulated learning skills. *Current Psychology*, *41*(9), 6406–6423. https://doi.org/10.1007/s12144-020-01136-x

Chacko, S., & Huba, M. (1991). Academic achievement among undergraduate nursing students: the development and test of a causal model. *Journal of Nursing Education*, *30*(6), 267–273. http://search.ebscohost.com/login.aspx?direct=true&db=cin20&AN=107507845&site=ehost-live

Chen, J. H., Björkman, A., Zou, J. H., & Engström, M. (2019). Self–regulated learning ability, metacognitive ability, and general self-efficacy in a sample of nursing students: A cross-sectional and correlational study. *Nurse Education in Practice*, *37*, 15–21. https://doi.org/10.1016/j.nepr.2019.04.014

Cheng, S. F., Kuo, C. L., Lin, K. C., & Lee-Hsieh, J. (2010). Development and preliminary testing of a self-rating instrument to measure self-directed learning ability of nursing students. *International Journal of Nursing Studies*, *47*(9), 1152–1158. https://doi.org/10.1016/j.ijnurstu.2010.02.002

Clark, L.A., & Watson, D., (1995), Constructing validity: basic issues in objective scale development. *Psychological Assessment, 7(3), 309-319.* https://doi.org.10.1037/1010-3590.7.3.309

Colthorpe, K., Abe, H., & Ainscough, L. (2018). How do students deal with difficult physiological knowledge? *Advances in Physiology Education*, *42*(4), 555–564. https://doi.org/10.1152/advan.00102.2018

Colthorpe, K., Ogiji, J., Ainscough, L., Zimbardi, K., & Anderson, S. (2019a). Effect of Metacognitive Prompts on Undergraduate Pharmacy Students' Self-regulated Learning Behavior. *American Journal of Pharmaceutical Education*, *83*(4), 6646. https://doi.org/10.5688/ajpe6646

Colthorpe, K., Ogiji, J., Ainscough, L., Zimbardi, K., & Anderson, S. (2019b). Metacognitive assessment tasks provide insight into undergraduate pharmacy students' self-regulated learning behavior. *American Journal of Pharmaceutical Education*, *83*(4), ajpe6646. https://doi.org/10.5688/ajpe6646

Colthorpe, K., Sharifirad, T., Ainscough, L., Anderson, S., & Zimbardi, K. (2017). Prompting undergraduate students' metacognition of learning: Implementing 'meta-learning' assessment tasks in the biomedical sciences. *Assessment and Evaluation in Higher Education*, *43*(2), 272–285. https://doi.org/10.1080/02602938.2017.1334872

Colthorpe, K., Zimbardi, K., Ainscough, L., & Anderson, S. (2015). Know thy student! Combining learning analytics and critical reflections to increase understanding of students' self-regulated learning in an authentic setting. *Journal of Learning Analytics*, *2*(1), 134–155. https://doi.org/https://doi.org/10.18608/jla.2015.21.7

Cook, E., Kennedy, E., & McGuire, S. Y. (2013). Effect of teaching metacognitive learning strategies on performance in general chemistry courses. *Journal of Chemical Education*, *90*(8), 961–967. https://doi.org/10.1021/ed300686h

Corno, L. (1994). Implicit teachings and self-regulated learning. *Annual Meeting of the American Educational Research Association*, 38–59. https://files.eric.ed.gov/fulltext/ED377140.pdf

Cowman, S. (1998). The approaches to learning of student nurses in the Republic of Ireland and Northern Ireland. *Journal of Advanced Nursing*, *28*(4), 899–910. https://doi.org/10.1046/j.1365-2648.1998.00733.x

Cox, J. L., & Crane, J. W. (2014). Shifting the focus: Increasing engagement and improving performance of nursing students in bioscience subjects using face-to-face workshops to reduce anxiety. *International Journal of Innovation in Science and Mathematics Education*, *22*(7).

Craft, J., Hudson, P. B., Plenderleith, M. B., & Gordon, C. J. (2017). Registered nurses' reflections on bioscience courses during the undergraduate nursing programme: an exploratory study. *Journal of Clinical Nursing*, *26*(11–12), 1669–1680. https://doi.org/10.1111/jocn.13569

Craft, J., Hudson, P., Plenderleith, M. B., Wirihana, L., & Gordon, C. J. (2013). Commencing nursing students' perceptions and anxiety of bioscience. *Nurse Education Today*, *33*(11), 1399–1405. https://doi.org/10.1016/j.nedt.2012.10.020

Crane, J. W., & Cox, J. L. (2013). More than just a lack of knowledge: A discussion of the potential hidden-impact of poor pre-enrolment science background on nursing student success in bioscience subjects. *International Journal of Innovation in Science and Mathematics Education*, *21*(2), 26–36. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.904.2987&rep=rep1&type=pdf

Credé, M., & Phillips, L. A. (2011). A meta-analytic review of the Motivated Strategies for Learning Questionnaire. *Learning and Individual Differences*, *21*(4), 337–346. https://doi.org/10.1016/j.lindif.2011.03.002

Curtis, S., & Williams, J. (2002). The reluctant workforce: Undergraduates' part-time employment. *Education + Training*, *44*(1), 5–10. https://doi.org/10.1108/00400910210416192

Darbyshire, P. (1993). In defence of pedagogy: A critique of the notion of andragogy. *Nurse Education Today*, *13*(5), 328–335. https://doi.org/10.1016/0260-6917(93)90072-A

Davies, S., Murphy, F., & Jordan, S. (2000). Bioscience in the pre-registration curriculum: Finding the right teaching strategy. *Nurse Education Today*, *20*(2), 123–135. https://doi.org/10.1054/nedt.1999.0375

Davis, G. M. (2010). What is provided and what the registered nurse needs--bioscience learning through the pre-registration curriculum. *Nurse Education Today*, *30*(8), 707–712. https://doi.org/10.1016/j.nedt.2010.01.008

de Bruin, A. B. H., Biwer, F., Hui, L., Onan, E., David, L., & Wiradhany, W. (2023). Worth the effort:

the Start and Stick to Desirable Difficulties (S2D2) framework. *Educational Psychology Review*, *35*(2). https://doi.org/10.1007/s10648-023-09766-w

Demirel, M., & Coşkun, Y. D. (2010). A study on the assesment of undergraduate students' learning preference. *Procedia - Social and Behavioral Sciences*, *2*(2), 4429–4435. https://doi.org/10.1016/j.sbspro.2010.03.706

Dibenedetto, M. K., & Zimmerman, B. J. (2013). Construct and predictive validity of microanalytic measures of students' self-regulation of science learning. *Learning and Individual Differences*, *26*, 30–41. https://doi.org/10.1016/j.lindif.2013.04.004

DiFrancesca, D., Nietfeld, J. L., & Cao, L. (2016). A comparison of high and low achieving students on self-regulated learning variables. *Learning and Individual Differences*, *45*, 228–236. https://doi.org/10.1016/j.lindif.2015.11.010

Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning*, *3*(3), 231–264. https://doi.org/10.1007/s11409-008-9029-x

Donker, A. S., de Boer, H., Kostons, D., Dignath van Ewijk, C. C., & van der Werf, M. P. C. (2014). Effectiveness of learning strategy instruction on academic performance: A meta-analysis. *Educational Research Review*, *11*, 1–26. https://doi.org/10.1016/j.edurev.2013.11.002

Dörrenbächer, L., & Perels, F. (2016a). More is more? Evaluation of interventions to foster self-regulated learning in college. *International Journal of Educational Research*, *78*, 50–65. https://doi.org/10.1016/j.ijer.2016.05.010

Dörrenbächer, L., & Perels, F. (2016b). Self-regulated learning profiles in college students: Their relationship to achievement, personality, and the effectiveness of an intervention to foster self-regulated learning. *Learning and Individual Differences*, *51*, 229–241. https://doi.org/10.1016/j.lindif.2016.09.015

Dresel, M., Schmitz, B., Schober, B., Spiel, C., Ziegler, A., Engelschalk, T., Jöstl, G., Klug, J., Roth, A., Wimmer, B., & Steuer, G. (2015). Competencies for successful self-regulated learning in higher education: structural model and indications drawn from expert interviews. *Studies in Higher Education*, *40*(3), 454–470. https://doi.org/10.1080/03075079.2015.1004236

Duggan, S., & Gott, R. (2002). What sort of science education do we really need ? *International Journal of Science Education*, *24*(7), 661–679. https://doi.org/10.1080/09500690110110133

Duncan, T. G., & Mckeachie, W. J. (2005). The making of the motivated strategies for learning questionnaire. *Educational Psychologist*, *40*(2), 117–128. https://doi.org/10.1207/s15326985ep4002_6

Dunlosky, J., & Rawson, K. A. (2012). Overconfidence produces underachievement: Inaccurate self evaluations undermine students' learning and retention. *Learning and Instruction*, *22*(4), 271–280. https://doi.org/10.1016/j.learninstruc.2011.08.003

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest, Supplement*, *14*(1), 4–58. https://doi.org/10.1177/1529100612453266

Dunn, K. E., Lo, W. J., Mulvenon, S. W., & Sutcliffe, R. (2012). Revisiting the Motivated Strategies for Learning Questionnaire: A theoretical and statistical reevaluation of the metacognitive self-regulation and effort regulation subscales. *Educational and Psychological Measurement*, *72*(2), 312–331. https://doi.org/10.1177/0013164411413461

Dunn, K. E., Osborne, C., & Link, H. J. (2012). Exploring the influence of students' attributions for success on their self-regulation in pathophysiology. *Journal of Nursing Education*, *51*(6), 353–357. https://doi.org/10.3928/01484834-20120420-01

Dwarika-Bhagat, N., Sa, B., & Majumder, M. A. A. (2017). Does study skill matter? A descriptive study on undergraduate health profession students in the University of the West Indies. *Education in Medicine Journal*, *9*(2), 27–40. https://doi.org/10.21315/eimj2017.9.2.3

Dyck, S. (1986). Self-directed learning for the RN in a baccalaureate program. *Journal of Continuing Education in Nursing*, *17*(6), 194–197. https://doi.org/10.3928/0022-0124-19861101-05

Dye, K. M., & Stanton, J. D. (2017). Metacognition in upper-division biology students: Awareness does not always lead to control. *CBE—Life Sciences Education*, *16*(2). https://doi.org/10.1187/cbe.16-09-0286

Eccles, J. S., & Wigfield, A. (2016). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. In *Cognitive and Moral Development, Academic Achievement in Adolescence* (pp. 131–141). https://doi.org/10.1177/0146167295213003

Entwistle, N., & McCune, V. (2004). The conceptual bases of study strategy inventories. *Educational Psychology Review*, *16*(4), 325–345.

Faul, F., Erdfelder, E., Lang, A-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioural, and biomedical sciences. *Behavior Research Methods, 39, 175-191.*

Felicilda-Reynaldo, R. F. D., Cruz, J. P., Bigley, L., & Adams, K. (2017). Baccalaureate student nurses' study habits prior to admission to nursing program: A descriptive qualitative study. *Nurse Education Today*, *53*, 61–66. https://doi.org/10.1016/j.nedt.2017.04.009

Field, A. (2020). Survey fatigue and the tragedy of the commons: Are we undermining our evaluation practice? *Evaluation Matters—He Take Tō Te Aromatawai*, 1–11. https://doi.org/10.18296/em.0054

Field, L. (1989). An investigation into the structure, validity, and reliability of Guglielmino's self-directed learning scale. *Adult Education Quarterly*, *39*, 125–139. https://doi.org/https://psycnet.apa.org/doi/10.1177/0001848189039003001

Field, L. (1990). Guglielmino's self-directed learning radiness scale: Should it continue to be used? *Adult Education Quarterly*, *41*(2), 100–103. https://doi.org/https://psycnet.apa.org/doi/10.1177/0001848191041002004

Finkel, A., Brown, T., Wright, J., & Wienk, M. (2020). *Mapping university prerequisites in Australia: A joint Office of the Chief Scientist and Australian Mathematical Sciences Institute paper*. https://www.chiefscientist.gov.au/news-and-media/mapping-university-prerequisites-australia

Fisher, M. J., King, J., & Tague, G. (2001). Development of a self-directed learning readiness scale for nursing education. *Nurse Education Today*, *21*(7), 516–525. https://doi.org/10.1054/nedt.2001.0589

Freeman, S., O'Connor, E., Parks, J. W., Cunningham, M., Hurley, D., Haak, D. C., Dirks, C., & Wenderoth, M. P. (2007). Prescribed active learning increases performance in introductory biology. *CBE—Life Sciences Education*, *6*(2), 132–139. https://doi.org/10.1187/cbe.06-09-0194

Friedel, J. M., & Treagust, D. F. (2005). Learning bioscience in nursing education: perceptions of the intended and the prescribed curriculum. *Learning in Health and Social Care*, *4*(4), 203–216. https://doi.org/10.1111/j.1473-6861.2005.00104.x

Garrison, D. R. (1997). Self-directed learning: towards a comprehensive model. *Adult Education Quarterly1*, *48*(1), 18–33. https://doi.org/https://doi.org/10.1177/074171369704800103

Geller, J., Toftness, A. R., Armstrong, P. I., Carpenter, S. K., Manz, C. L., Coffman, C. R., & Lamm, M. H. (2018). Study strategies and beliefs about learning as a function of academic achievement and achievement goals. *Memory*, *26*(5), 683–690. https://doi.org/10.1080/09658211.2017.1397175

Gordon, C. J., Hudson, P. B., Plenderleith, M. B., Fisher, M. J., & Craft, J. (2017). Final year Australian nursing students' experiences with bioscience: A cross-sectional survey. *Nursing and Health Sciences*, *19*(1), 22–28. https://doi.org/10.1111/nhs.12310

Grady, P. A. (2011). Advancing the health of our aging population: A lead role for nursing science. *Nursing Outlook*, *59*(4), 207–209. https://doi.org/10.1016/j.outlook.2011.05.017

Greene, J. A. (2017). *Self-regulation in education*. Routledge. https://doi.org/https://doi.org/10.4324/9781315537450

Grow, G. (1991). Teaching learners to be self-directed. *Adult Education Quarterly*, *41*(3), 125–149. https://doi.org/https://doi.org/10.1177/0001848191041003001

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough?: An experiment with data saturation and variability. *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822X05279903

Guglielmino, L. M. (1977). *Development of the self-directed learning readiness scale.* University of Georgia.

Haak, D. C., HilleRisLambers, J., Pitre, E., & Freeman, S. (2011). Increased structure and active learning reduce the achievement gap in introductory biology. *Science*, *332*(6034), 1213–1216. https://doi.org/10.1126/science.1204820

Haikalis, M., Doucette, H., Meisel, M. K., Birch, K., & Barnett, N. P. (2022). Changes in college student anxiety and depression from pre- to during-COVID-19: Perceived stress, academic challenges, loneliness, and positive perceptions. *Emerging Adulthood*, *10*(2), 534–545. https://doi.org/10.1177/21676968211058516

Hailikari, T., Nevgi, A., & Komulainen, E. (2008). Academic self-beliefs and prior knowledge as predictors of student achievement in Mathematics: A structural model. *Educational Psychology*, *28*(1), 59–71. https://doi.org/10.1080/01443410701413753

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American Psychologist*, *53*(4), 449–455. https://doi.org/10.1037/0003-066X.53.4.449

Hardy, D. L. (2013). *Learning strategies and motivational patterns, as measured by the Motivated Strategies for Learning Questionnaire, among students pursuing nursing and allied health careers* (Vol. 3671114). The University of Akron.

Hattie, J. A. C., Biggs, J., & Pugh, K. J. (1996). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research*, *66*(2), 99–136. https://doi.org/10.3102/00346543066002099

Hattie, J. A. C., & Donoghue, G. M. (2016). Learning strategies: a synthesis and conceptual model. *Npj Science of Learning*, *1*(1), 16013. https://doi.org/10.1038/npjscilearn.2016.13

Hilpert, J. C., Stempien, J., Van Der Hoeven Kraft, K. J., & Husman, J. (2013). Evidence for the latent factor structure of the MSLQ: A new conceptualization of an established questionnaire. *SAGE Open*, *3*(4). https://doi.org/10.1177/2158244013510305

Hodges, C., & Fowler, D. (2021). COVID-19 crisis and faculty members in higher education: From emergency remote teaching to better teaching through reflection. *International Journal of Multidisciplinary Perspectives in Higher Education*, *5*(1), 118–122. https://doi.org/10.32674/jimphe.v5i1.2507

Hodges, C., Moore, S., Lockee, B. B., Trust, T., & Bond, A. (2020, March 27). The difference between emergency remote teaching and online learning. *EDUCAUSE Review*. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Hofer, B. K., & Yu, S. L. (2003). Teaching self-regulated learning through a “Learning to Learn” course. *Teaching of Psychology*, *30*(1), 30–33. https://doi.org/10.1207/S15328023TOP3001_05

Honicke, T., & Broadbent, J. (2016). The influence of academic self-efficacy on academic performance: A systematic review. *Educational Research Review*, *17*, 63–84. https://doi.org/10.1016/j.edurev.2015.11.002

Hume, A., & Coll, R. (2010). Authentic student inquiry: The mismatch between the intended curriculum and the student-experienced curriculum. *Research in Science and Technological Education*, *28*(1), 43–62. https://doi.org/10.1080/02635140903513565

Hurst, K. (1985). Traditional versus progressive nurse education: a review of the literature. *Nurse Education Today*, *5*(1), 30–36. https://doi.org/10.1016/0260-6917(85)90070-X

Husmann, P. R., Hoffman, L. A., & Schaefer, A. F. (2018). Unique terms or are we splitting hairs? Clarification of self-directed versus self-regulated learning and related terms. *Medical Science Educator*, *28*(4), 777–783. https://doi.org/10.1007/s40670-018-0626-2

Irvine, S., Williams, B., Smallridge, A., Solomonides, I., Gong, Y. H., & Andrew, S. (2021). The self-regulated learner, entry characteristics and academic performance of undergraduate nursing students transitioning to University. *Nurse Education Today*, *105*(June), 105041. https://doi.org/10.1016/j.nedt.2021.105041

Iwasiw, C. (1987). The role of the teacher in self-directed learning. *Nurse Education Today*, *7*(5), 222–227. https://doi.org/10.1016/0260-6917(87)90005-0

Iyama, S., & Maeda, H. (2018). Development of the self-regulated learning scale in clinical nursing practice for nursing students: Consideration of its reliability and validity. *Japan Journal of Nursing Science*, *15*(3), 226–236. https://doi.org/10.1111/jjns.12191

Jackson, C. R. (2018). Validating and adapting the Motivated Strategies for Learning Questionnaire (MSLQ) for STEM courses at an HBCU. *AERA Open*, *4*(4), 1–16. https://doi.org/10.1177/2332858418809346

James Cook University. (2020, March 18). *JCU COVID-19 repsonse [Press release]*. https://www.jcu.edu.au/news/releases/2020/march/jcu-covid-19-response

Jansen, R. S., van Leeuwen, A., Janssen, J., Jak, S., & Kester, L. (2019). Self-regulated learning partially mediates the effect of self-regulated learning interventions on achievement in higher education: A meta-analysis. *Educational Research Review*, *28*(June), 100292. https://doi.org/10.1016/j.edurev.2019.100292

Jensen, K. T., Knutstad, U., & Fawcett, T. N. (2018). The challenge of the biosciences in nurse education: A literature review. *Journal of Clinical Nursing*, *27*(9–10), 1793–1802. https://doi.org/10.1111/jocn.14358

Johnston, A. N. B., Hamill, J., Barton, M. J., Baldwin, S., Percival, J., Williams-Pritchard, G. A., Salvage-Jones, J., & Todorovic, M. (2015). Student learning styles in anatomy and physiology courses: Meeting the needs of nursing students. *Nurse Education in Practice*, *15*(6), 415–420. https://doi.org/10.1016/j.nepr.2015.05.001

Jones, W. J. (1981). Self directed learning and student selected goals in nurse education. *Journal of Advanced Nursing*, *6*(1), 59–69. https://doi.org/10.1111/j.1365-2648.1981.tb03096.x

Jordan, S., Davies, S., & Green, B. (1999). The biosciences in the pre-registration nursing curriculum: staff and students' perceptions of difficulties and relevance. *Nurse Education Today*, *19*(3), 215–226. https://doi.org/https://doi.org/10.1016/S0260-6917(99)80007-0

Karpicke, J. D., & Aue, W. R. (2015). The testing effect is alive and well with complex materials. *Educational Psychology Review*, *27*(2), 317–326. https://doi.org/10.1007/s10648-015-9309-3

Kasworm, C. (1988). Self-directed learning in institutional contexts: An exploratory study of adult self-directed learners in higher education. In H. B. Long (Ed.), *Self-directed learning: Application and theory.* Adult Education Department, University of Georgia.

Kaulback, M. K. (2020). Correlating self-directed learning abilities to lifelong learning orientation in baccalaureate nursing students. *Nurse Educator*, *45*(6), 347–351. https://doi.org/10.1097/NNE.0000000000000803

Keçeci, A. (2017). Self-regulated learning in nursing: A study from a health education course. *Journal of Human Sciences*, *14*(4). https://doi.org/10.14687/jhs.v14i4.4415

Kemp, L. A., Harris, E., & Comino, E. J. (2005). Changes in community nursing in Australia: 1995-2000. *Journal of Advanced Nursing*, *49*(3), 307–314. https://doi.org/10.1111/j.1365-2648.2004.03289.x

Knowles, M. S. (1975). *Self-directed learning: A guide for learners and teachers.* Cambridge Adult Education Prentice Hall Regents.

Knowles, M. S. (1980). *The modern practice of adult education: From pedagogy to andragogy.* (2nd ed.). Cambridge, The Adult Education Company.

Kocaman, G., Dicle, A., & Ugur, A. (2009). A longitudinal analysis of the self-directed learning readiness level of nursing students enrolled in a problem-based curriculum. *Journal of Nursing Education*, *48*(5), 286–290. https://doi.org/10.9999/01484834-20090416-09

Kornell, N., & Vaughn, K. E. (2016). How Retrieval Attempts Affect Learning: A Review and Synthesis. *Psychology of Learning and Motivation - Advances in Research and Theory*, *65*(May), 183–215. https://doi.org/10.1016/bs.plm.2016.03.003

Kosnin, A. M. (2007). Self-regulated learning and academic achievement in Malaysian undergraduates. *International Education Journal*, *8*(1), 221–228.

Lan, W. Y. (1998). Teaching self-monitoring skills in statistics. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulated learning: From teaching to self-reflective practice* (pp. 86–105). The Guildford Press.

Lee, W., Chiang, C. H., Liao, I. C., Lee, M.-L., Chen, S.-L., & Liang, T. (2013). The longitudinal effect of concept map teaching on critical thinking of nursing students. *Nurse Education Today*, *33*(10), 1219–1223. https://doi.org/10.1016/j.nedt.2012.06.010

Linnenbrink, E. A., & Pintrich, P. R. (2002). Motivation as an enabler for academic success. *School*

Psychology Review, *31*(3), 313–327. https://doi.org/10.1080/02796015.2002.12086158

Littrell-Baez, M. K., Friend, A., Caccamise, D., & Okochi, C. (2015). Using retrieval practice and metacognitive skills to improve content learning. *Journal of Adolescent and Adult Literacy*, *58*(8), 682–689. https://doi.org/10.1002/jaal.420

Lloyd, N., Sealey, R., & Logan, M. (2021). Balancing the COVID-19 disruption to undergraduate learning and assessment with an academic student support package: Implications for student achievement and engagement. *Student Success*, *12*(2), 61–71. https://doi.org/10.5204/ssj.1933

Logan, P. A., & Angel, L. (2014). Exploring Australian undergraduate pre-registration nursing curricula: Where do science subjects fit? *Journal of Learning Design*, *7*(2), 62–84.

Long, H. B. (1990). Psychological control in self-directed learning. *International Journal of Lifelong Education*, *9*(4), 331–338. https://doi.org/10.1080/0260137900090405

Love, P. G., & Guthrie, V. L. (1999). Perry's intellectual scheme. *New Directions for Student Services*, *1999*(88), 5–15. https://doi.org/10.1002/ss.8801

Loyens, S. M. M., Magda, J., & Rikers, R. M. J. P. (2008). Self-directed learning in problem-based learning and its relationships with self-regulated learning. *Educational Psychology Review*, *20*(4), 411–427. https://doi.org/10.1007/s10648-008-9082-7

Lukes, L. A., Jones, J. P., & Mcconnell, D. A. (2020). Self-regulated learning : Overview and potential future directions in geoscience. *Journal of Geoscience Education*, *0*(0), 1–13. https://doi.org/10.1080/10899995.2020.1820828

Lyke, J. A., & Kelaher Young, A. J. (2006). Cognition in context: Students' perceptions of classroom goal structures and reported cognitive strategy use in the college classroom. In *Research in Higher Education* (Vol. 47, Issue 4, pp. 477–490). https://doi.org/10.1007/s11162-005-9004-1

Lyons, K., McLaughlin, J. E., Khanova, J., & Roth, M. T. (2017). Cognitive apprenticeship in health sciences education: a qualitative review. *Advances in Health Sciences Education*, *22*(3), 723–739. https://doi.org/10.1007/s10459-016-9707-4

Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis : A practical , step-by-step guide for learning and teaching scholars . *All Ireland Journal of Teaching and Learning in Higher Education*, *9*(3), 335.1-335.14. https://ojs.aishe.org/index.php/aishe-j/article/view/335

Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample size in qualitative interview studies: Guided by information power. *Qualitative Health Research*, *26*(13), 1753–1760.

https://doi.org/10.1177/1049732315617444

Martin, L. (2020). Foundations for good practice: The student experience of online learning in Australian higher education during the COVID-19 pandemic. *Teqsa*, *November*. https://files.eric.ed.gov/fulltext/ED610395.pdf

Maurer, T., Allen, D., Gatch, D. B., Shankar, P., & Sturges, D. (2013). A comparison of student academic motivations across three course disciplines. *Journal of the Scholarship of Teaching and Learning*, *13*(5), 77–89.

Maurer, T., Allen, D., Gatch, D., Shankar, P., & Sturges, D. (2012). Students' academic motivations in allied health classes. *The Internet Journal of Allied Health Sciences and Practice*, *10*(1), 1–12. https://doi.org/10.46743/1540-580X/2012.1384

McCarthy, G. (1995). Research on teaching methods in nursing. In D. M. Modly, J. J. Fitzpatrick, P. Poletti, & R. Zanotti (Eds.), *Advancing nursing education worldwide* (pp. 45–58). Springer Publishing Company.

McKay, L., O'bryan, S., & Kahu, E. R. (2021). "My uni experience wasn't completely ruined": The impacts of COVID-19 on the first-year experience. *Student Success*, *12*(3), 1–13. https://doi.org/10.5204/ssj.1762

Mckee, G. (2002). Why is biological science difficult for first-year nursing students? *Nurse Education Today*, *22*(3), 251–257. https://doi.org/10.1054/nedt.2001.0700

McVicar, A., Andrew, S., & Kemble, R. (2014). Biosciences within the pre-registration (pre-requisite) curriculum: an integrative literature review of curriculum interventions 1990-2012. *Nurse Education Today*, *34*(4), 560–568. https://doi.org/10.1016/j.nedt.2013.08.012

McVicar, A., Andrew, S., & Kemble, R. (2015). The "bioscience problem" for nursing students: an integrative review of published evaluations of Year 1 bioscience, and proposed directions for curriculum development. *Nurse Education Today*, *35*(3), 500–509. https://doi.org/10.1016/j.nedt.2014.11.003

McWatt, S. C. (2021). Responding to Covid-19: A thematic analysis of students' perspectives on modified learning activities during an emergency transition to remote human anatomy education. *Anatomical Sciences Education*, *14*(6), 721–738. https://doi.org/10.1002/ase.2136

Merriam, S. B., & Baumgartner, L. M. (2020). Self-directed learning. In *Learning in adulthood: A comprehensive guide*. John Wiley & Sons, Inc.

Michael, J. (2007). What makes physiology hard for students to learn? Results of a faculty survey. *Advances in Physiology Education*, *31*(1), 34–40. https://doi.org/10.1152/advan.00057.2006

Mikkelsen, T. R. (2015). Nursing students' experiences, perceptions and behavior in a flipped-classroom anatomy and physiology course. *Journal of Nursing Education and Practice*, *5*(10). https://doi.org/10.5430/jnep.v5n10p28

Mitchell, J. (2020). Juggling employment and studies: Nursing students' perceptions of the influence of paid employment on their success. *Nurse Education Today*, *92*(April), 104429. https://doi.org/10.1016/j.nedt.2020.104429

Molesworth, M., & Lewitt, M. (2016). Preregistration nursing students' perspectives on the learning, teaching and application of bioscience knowledge within practice. *Journal of Clinical Nursing*, *25*(5–6), 725–732. https://doi.org/10.1111/jocn.13020

Momsen, J. L., Long, T. M., Wyse, S. A., & Ebert-May, D. (2010). Just the facts? introductory undergraduate biology courses focus on low-level cognitive skills. *CBE Life Sciences Education*, *9*(4), 435–440. https://doi.org/10.1187/cbe.10-01-0001

Montayre, J., Dimalapang, E., Sparks, T., & Neville, S. (2019). New Zealand nursing students' perceptions of biosciences: A cross-sectional survey of relevance to practice, teaching delivery, self-competence and challenges. *Nurse Education Today*, *79*(May), 48–53. https://doi.org/10.1016/j.nedt.2019.05.013

Montayre, J., Ramjan, L. M., Maneze, D., Ho, M. H., Maceri, A., & Salamonson, Y. (2021). "Connecting the dots" – The transfer of bioscience knowledge by new graduate nurses to the clinical setting : A qualitative study. *Nurse Education Today*, *97*(December 2020), 104729. https://doi.org/10.1016/j.nedt.2020.104729

Montero, C. R., Sierra, B., & Arizmendiarrieta. (2017). The effectiveness of a learning strategies program for university students. *Psicothema*, *29*(4), 527–532. https://doi.org/10.7334/psicothema2016.171

Montrezor, L. H. (2016). Performance in physiology evaluation: possible improvement by active learning strategies. *Advances in Physiology Education*, *40*(4), 454–457. https://doi.org/10.1152/advan.00022.2016

Mortimer-Jones, S. M., & Fetherston, C. (2018). The nursification of a bioscience unit and its impact on student satisfaction and learning in an undergraduate nursing degree. *Nurse Education Today*, *64*, 1–4. https://doi.org/10.1016/j.nedt.2018.02.006

Newton, P. M., Da Silva, A., & Peters, L. G. (2020). A pragmatic master list of action verbs for Bloom's taxonomy. *Frontiers in Education*, *5*(July), 1–6. https://doi.org/10.3389/feduc.2020.00107

Nicoll, L., & Butler, M. (1996). The study of biology as a cause of anxiety in student nurses undertaking the common foundation programme. *Journal of Advanced Nursing*, *24*(3), 615–624. https://doi.org/10.1046/j.1365-2648.1996.23224.x

Nilsson, K. E., & Warren Stomberg, M. I. (2008). Nursing students motivation toward their studies - a survey study. *BMC Nursing*, *7*, 6. https://doi.org/10.1186/1472-6955-7-6

Ningrum, R. K., Kumara, A., & Prabandari, Y. S. (2018). The relationship between self-regulated learning and academic achievement of undergraduate medical students. *IOP Conference Series: Materials Science and Engineering*, *434*(1). https://doi.org/10.1088/1757-899X/434/1/012155

Nolan, J., & Nolan, M. (1997a). Self-directed and student-centred learning in nurse education: 1. *British Journal of Nursing*, *6*(1), 51–57. https://doi.org/https://doi.org/10.12968/bjon.1997.6.1.51

Nolan, J., & Nolan, M. (1997b). Self-directed and student-centred learning in nurse education: 2. *British Journal of Nursing*, *6*(2), 103–108. https://doi.org/https://doi.org/10.12968/bjon.1997.6.2.103

Nota, L., Soresi, S., & Zimmerman, B. J. (2004). Self-regulation and academic achievement and resilience: A longitudinal study. *International Journal of Educational Research*, *41*(3), 198–215. https://doi.org/10.1016/j.ijer.2005.07.001

O'Shea, E. (2003). Self-directed learning in nurse education: A review of the literature. *Journal of Advanced Nursing*, *43*(1), 62–70. https://doi.org/10.1046/j.1365-2648.2003.02673.x

Olsen, J. M. (2017). Integrative review of admission factors related to Associate Degree nursing program success. *Journal of Nursing Education*, *56*(2), 85–93. https://doi.org/http://dx.doi.org/10.3928/01484834-20170123-05

Örs, M., & Titrek, O. (2018). The correlation between metacognitive awareness level and self-directed learning readiness of undergraduate nursing and midwifery students. *Journal of Education and Training Studies*, *6*(11a), 218. https://doi.org/10.11114/jets.v6i11a.3819

Osgood Smith, J., & Price, R. A. (1996). Attribution theory and developmental students as passive learners. *1Journal of Developmental Education*, *19*(3), 2.

Owens, D. C., Sadler, T. D., Barlow, A. T., & Smith-Walters, C. (2020). Student motivation from and resistance to active learning rooted in essential science practices. *Research in Science Education*, *50*(1), 253–277. https://doi.org/10.1007/s11165-017-9688-1

Page, J., Meehan-Andrews, T. A., Weerakkody, N., Hughes, D. L., & Rathner, J. A. (2017). Student perceptions and learning outcomes of blended learning in a massive first-year core physiology for allied health subjects. *Advances in Physiology Education*, *41*(1), 44–55. https://doi.org/10.1152/advan.00005.2016

Pajares, F. (1996). Self-Efficacy Beliefs in Academic Settings. *Review of Educational Research*, *66*(4), 543–578. https://doi.org/10.3102/00346543066004543

Pajares, F. (2008). Motivational role of self-efficacy beliefs in self-regulated learning. In *Motivation and Self-Regulated Learning: Theory, Research, and Applications* (Issue 2007, pp. 111–139). https://doi.org/10.4324/9780203831076

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology*, *8*(APR), 422. https://doi.org/10.3389/fpsyg.2017.00422

Panadero, E., Jonsson, A., & Botella, J. (2017). Effects of self-assessment on self-regulated learning and self-efficacy: Four meta-analyses. *Educational Research Review*, *22*, 74–98. https://doi.org/10.1016/j.edurev.2017.08.004

Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist*, *36*(2), 89–101. https://doi.org/10.1207/S15326985EP3602_4

Parpala, A., Lindblom-Ylänne, S., Komulainen, E., Litmanen, T., & Hirsto, L. (2010). Students' approaches to learning and their experiences of the teaching-learning environment in different disciplines. *British Journal of Educational Psychology*, *80*(2), 269–282. https://doi.org/10.1348/000709909X476946

Peel, K. L. (2020). A beginner's guide to applied educational research using thematic analysis. *Practical Assessment, Research and Evaluation*, *25*(2), 1–15. https://doi.org/https://doi.org/10.7275/ryr5-k983

Perkins, C. (2019). Enhanced bioscience content is urgently needed in UK pre-registration nursing curricula. *Nurse Education in Practice*, *34*(July 2018), 7–11. https://doi.org/10.1016/j.nepr.2018.10.008

Perrot, L. J., Deloney, L. A., Hastings, J. K., Savell, S., & Savidge, M. (2001). Measuring student motivation in health professions' colleges. *Advances in Health Sciences Education*, *6*(3), 193–203. https://doi.org/10.1023/A:1012606722230

Peterson, V. M. (2009). Predictors of academic success in first semester baccalaureate nursing students. *Social Behavior and Personality*, *37*(3), 411–417. https://doi.org/10.2224/sbp.2009.37.3.411

Phillips, C., Kenny, A., & Esterman, A. (2016). Pre-registration paid employment practices of undergraduate nursing students: A scoping review. *Collegian*, *23*(1), 115–127. https://doi.org/10.1016/j.colegn.2014.09.012

Pintrich, P. R. (1995). Understanding self-regulated learning. *New Directions for Teaching and Learning*, *1995*(63), 3–12. https://doi.org/10.1002/tl.37219956304

Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research*, *31*(6), 459–470. https://doi.org/10.1016/S0883-0355(99)00015-4

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 451–502). Elsevier. https://doi.org/10.1016/B978-012109890-2/50043-3

Pintrich, P. R. (2002). The role of metacognitive knowledge in learning, teaching, and assessing. *Theory Into Practice*, *41*(4), 219–225. https://doi.org/10.1207/s15430421tip4104_3

Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Psychology Review*, *16*(4), 385–407. https://doi.org/DOI 10.1007/s10648-004-0006-x

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33–40. https://doi.org/10.1037/0022-0663.82.1.33

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the motivated strategies for learning questionnaire (MSLQ)*. https://files.eric.ed.gov/fulltext/ED338122.pdf

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement*, *53*(3), 801–813. https://doi.org/10.1177/0013164493053003024

Pintrich, P. R., & Zusho, A. (2002). The development of academic self-regulation: The role of cognitive and motivational factors. In *Development of Achievement Motivation* (pp. 249–284). Academic Press.

Pitman, T. (2017). Widening participation in higher education: a play in five acts. *Australian Universities' Review*, *59*(1), 37–46.

Pratt, D. D. (1988). Andragogy as a relational construct. *Adult Education Quarterly*, *38*(3), 160–181. https://doi.org/https://doi.org/10.1177/0001848188038003004

Pressley, M., Borkwoski, J. G., & Schneider, W. (1989). Good information processing: What it is and how education can promote it. *International Journal of Educational Research*, *13*(8), 857–867. https://doi.org/10.1016/0883-0355(89)90069-4

Prowse, M. A., & Lyne, P. A. (2000). Revealing the contribution of bioscience-based nursing knowledge to clinically effective patient care. *Clinical Effectiveness in Nursing*, *4*(2), 67–74. https://doi.org/10.1054/cein.2000.0105

Ralph, N., Birks, M., Cant, R., Chun Tie, Y., & Hillman, E. (2017). How should science be taught to nurses? Preferences of registered nurses and science teaching academics. *Collegian*, *24*(6), 585–591. https://doi.org/10.1016/j.colegn.2017.01.004

Ralph, N., Graham, C., Beccaria, L., & Rogers, C. (2019). Entry requirements in nursing: Results from a national survey of nurse academics on entry requirements in Australian bachelor of nursing programs. *Collegian*, *26*(1), 140–145. https://doi.org/10.1016/j.colegn.2018.06.005

Rathner, J. A., & Byrne, G. (2014). The use of team-based, guided inquiry learning to overcome educational disadvantages in learning human physiology: a structural equation model. *Advances in Physiology Education*, *38*(3), 221–228. https://doi.org/10.1152/advan.00131.2013

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, *138*(2), 353–387. https://doi.org/10.1037/a0026838

Robb, M. K. (2015). Self-regulated learning: examining the baccalaureate millennial nursing student's approach. *Nursing Education Perspectives*, *37*(3), 162–164. https://doi.org/10.5480/14-1349

Robbins, S. B., Le, H., Davis, D., Lauver, K., Langley, R., & Carlstrom, A. (2004). Do psychosocial and study skill factors predict college outcomes? A meta-analysis. *Psychological Bulletin*, *130*(2), 261–288. https://doi.org/10.1037/0033-2909.130.2.261

Roth, A., Ogrin, S., & Schmitz, B. (2015). Assessing self-regulated learning in higher education: A systematic literature review of self-report instruments. *Educational Assessment, Evaluation and Accountability*, *28*(3), 225–250. https://doi.org/10.1007/s11092-015-9229-2

Rovers, S. F. E., Clarebout, G., & Savelberg, H. H. C. M. (2019). Granularity matters : comparing different ways of measuring self-regulated learning. *Metacognition and Learning*, *February*. https://doi.org/10.1007/s11409-019-09188-6

Saks, K., & Leijen, Ä. (2014). Distinguishing self-directed and self-regulated learning and measuring them in the e-learning context. *Procedia - Social and Behavioral Sciences*, *112*(Iceepsy 2013), 190–198. https://doi.org/10.1016/j.sbspro.2014.01.1155

Salamonson, Y., Everett, B., Koch, J., Andrew, S., & Davidson, P. M. (2012). The impact of term-time paid work on academic performance in nursing students: A longitudinal study. *International Journal of Nursing Studies*, *49*(5), 579–585. https://doi.org/10.1016/j.ijnurstu.2011.10.012

Salamonson, Y., Everett, B., Koch, J., Wilson, I., & Davidson, P. M. (2009). Learning strategies of first year nursing and medical students: A comparative study. *International Journal of Nursing Studies*, *46*(12), 1541–1547. https://doi.org/10.1016/j.ijnurstu.2009.05.010

Salamonson, Y., Ramjan, L. M., van den Nieuwenhuizen, S., Metcalfe, L., Chang, S., & Everett, B. (2016). Sense of coherence, self-regulated learning and academic performance in first year nursing students: A cluster analysis approach. *Nurse Education in Practice*, *17*, 208–213. https://doi.org/http://dx.doi.org/10.1016/j.nepr.2016.01.001

Salamonson, Y., Roach, D., Crawford, R., McGrath, B., Christiansen, A., Wall, P., Kelly, M., & Ramjan, L. M. (2020). The type and amount of paid work while studying influence academic performance of first year nursing students: An inception cohort study. *Nurse Education Today*, *84*(August 2019), 104213. https://doi.org/10.1016/j.nedt.2019.104213

Salamonson, Y., Weaver, R., Chang, S., Koch, J., Bhathal, R., Khoo, C., & Wilson, I. (2013). Learning approaches as predictors of academic performance in first year health and science students. *Nurse Education Today*, *33*(7), 729–733. https://doi.org/10.1016/j.nedt.2013.01.013

Salvage-Jones, J., Hamill, J., Todorovic, M., Barton, M. J., & Johnston, A. N. B. (2016). Developing and evaluating effective bioscience learning activities for nursing students. *Nurse Education in Practice*, *19*, 63–69. https://doi.org/10.1016/j.nepr.2016.05.005

Sand-Jecklin, K. (2007). The impact of active/cooperative instruction on beginning nursing student learning strategy preference. *Nurse Education Today*, *27*(5), 474–480. https://doi.org/10.1016/j.nedt.2006.08.006

Sandelowski, M. (2000). Focus on research methods: Whatever happened to qualitative description ? *Research in Nursing & Health*, *23*, 334–340.

Sandelowski, M. (2010). What's in a name? Qualitative description revisited. *Research in Nursing and Health*, *33*(1), 77–84. https://doi.org/10.1002/nur.20362

Sanders, D., & Welk, D. S. (2005). Strategies to scaffold student learning: applying Vygotsky's Zone of Proximal Development. *Nurse Educator*, *30*(5), 203–207. https://doi.org/10.1097/00006223-200509000-00007

Schneider, M., & Preckel, F. (2017). Variables associated with achievement in higher education: A systematic review of meta-analyses. *Psychological Bulletin*, *143*(6), 565–600. https://doi.org/10.1037/bul0000098

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education*, *36*(1–2), 111–139. https://doi.org/10.1007/s11165-005-3917-8

Schunk, D. H. (1993). Enhancing strategy use: Influences of strategy value and goal orientation. *Annual Meeting of the American Educational Research Association*. https://files.eric.ed.gov/fulltext/ED359217.pdf

Schunk, D. H. (2005). Self-regulated learning: The educational legacy of Paul R. Pintrich. *Educational Psychologist*, *40*(2), 85–94. https://doi.org/10.1207/s15326985ep4002_3

Schunk, D. H., & Dibenedetto, M. K. (2018). Self-efficacy theory in education. In K. R. Wentzel & D. B. Miele (Eds.), *Handbook of motivation at school* (Issue 11716, pp. 34–54). Routledge. https://doi.org/10.4324/9781315773384.ch3

Schunk, D. H., & Ertmer, P. A. (2000). Self-regulation and academic learning: Self-efficacy enhancing interventions. In Monique Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 631–647). Academic Press.

Schunk, D. H., & Pajares, F. (2009). Self-efficacy theory. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of Motivation at School* (pp. 35–54). Routledge.

Schunk, D. H., & Zimmerman, B. J. (1998). *Self-regulated learning: From teaching to self-reflective practice*. Guilford Press.

Scully, D. (2017). Constructing multiple-choice items to measure higher-order thinking. *Practical Assessment, Research and Evaluation*, *22*(4), 1–13.

Shields, L., & Watson, R. (2007). The demise of nursing in the United Kingdom: A warning for medicine. *Journal of the Royal Society of Medicine*, *100*(2), 70–74.

https://doi.org/10.1258/jrsm.100.2.70

Shrestha, S., Devkota, R., & Shrestha, B. (2018). Students' perception regarding the integration of basic sciences courses in nursing curriculum. *Kathmandu University Medical Journal (KUMJ)*, *16*(63), 225–230. http://www.kumj.com.np/issue/63/225-230.pdf

Shuell, T. (1990). Phases of meaningful learning. *Review of Educational Research*, *60*(4), 531–547. https://doi.org/10.3102/00346543060004531

Shulruf, B., Wang, Y. G., Zhao, Y. J., & Baker, H. (2011). Rethinking the admission criteria to nursing school. *Nurse Education Today*, *31*(8), 727–732. https://doi.org/10.1016/j.nedt.2010.11.024

Siegesmund, A. (2017). Using self-assessment to develop metacognition and self-regulated learners. *FEMS Microbiology Letters*, *364*(11), 1–4. https://doi.org/10.1093/femsle/fnx096

Slater, C. E., & Cusick, A. (2017). Factors related to self-directed learning readiness of students in health professional programs: A scoping review. *Nurse Education Today*, *52*, 28–33. https://doi.org/10.1016/j.nedt.2017.02.011

Slater, C. E., Cusick, A., & Louie, J. C. Y. (2017). Explaining variance in self-directed learning readiness of first year students in health professional programs. *BMC Medical Education*, *17*(1). https://doi.org/10.1186/s12909-017-1043-8

Slevin, O. D., & Lavery, M. C. (1991). Self-directed learning and student supervision. *Nurse Education Today*, *11*(5), 368–377. https://doi.org/10.1016/0260-6917(91)90037-B

Slominski, T., Grindberg, S., & Momsen, J. (2019). Physiology is hard: A replication study of students' perceived learning difficulties. *Advances in Physiology Education*, *43*(2), 121–127. https://doi.org/10.1152/advan.00040.2018

Smales, K. (2010). Learning and applying biosciences to clinical practice in nursing. *Nursing Standard*, *24*(33), 35–39. https://doi.org/10.7748/ns2010.04.24.33.35.c7716

Smedley, A. (2007). The self-directed learning readiness of first year bachelor of nursing students. *Journal of Research in Nursing*, *12*(4), 373–385. https://doi.org/10.1177/1744987107077532

Snelgrove, S. R. (2004). Approaches to learning of student nurses. *Nurse Education Today*, *24*(8), 605–614. https://doi.org/10.1016/j.nedt.2004.07.006

Snelling, P. C., Lipscomb, M., Lockyer, L., Yates, S., & Young, P. (2010). Time spent studying on a pre-registration nursing programme module: An exploratory study and implications for regulation. *Nurse Education Today*, *30*(8), 713–719. https://doi.org/10.1016/j.nedt.2010.01.010

Stanton, J. D., Neider, X. N., Gallegos, I. J., & Clark, N. C. (2015). Differences in metacognitive regulation in introductory biology students: When prompts are not enough. *CBE—Life Sciences Education*, *14*, 1–12. https://doi.org/10.1187/cbe.14-08-0135

Steiner, H. H., Trivedi, N. H., & Brown, J. A. (2019). Bringing a learning strategies project to scale in a first-year seminar. *Journal of Effective Teaching in Higher Education*, *1*(2), 27–44.

Straka, G. A., & Hinz, I. M. (1996). The original self-directed readiness scale reconsidered. *International Self-Directed Learning Symposium*, 3–18. https://eric.ed.gov/?id=ED392961

Sturges, D., & Maurer, T. (2013). Allied health students' perceptions of class difficulty: The case of undergraduate human anatomy and physiology classes. *The Internet Journal of Allied Health Sciencies and Practice*, *11*(4).

Sturges, D., Maurer, T., Allen, D., Gatch, D. B., & Shankar, P. (2016). Academic performance in human anatomy and physiology classes: a 2-yr study of academic motivation and grade expectation. *Advances in Physiology Education*, *40*(1), 26–31. https://doi.org/10.1152/advan.00091.2015

Sturges, D., Maurer, T., & Kosturik, A. (2017). Using study guides in undergraduate human anatomy and physiology classes: Student perceptions and academic performance. *International Journal of Kinesiology in Higher Education*, *1*(1), 18–27. https://doi.org/10.1080/24711616.2016.1277672

Sungur, S., & Tekkaya, C. (2006). Effects of problem-based learning and traditional instruction on self-regulated learning. *The Journal of Educational Research*, *99*(5), 307–320. https://doi.org/10.3200/joer.99.5.307-320

Sutcliffe, L. (1993). An investigation into whether nurses change their learning style according to subject area studied. *Journal of Advanced Nursing*, *18*(4), 647–658. https://doi.org/10.1046/j.1365-2648.1993.18040647.x

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2, 53-55.* https://doi.org/10.5116/ijme.4dfbf.8dfd

Taylor, B. (1995). Self-directed learning: Revisiting an idea most appropriate for middle school students. *Combined Meeting of the Great Lakes and Southeast International Reading Assoication*, 2–8. https://files.eric.ed.gov/fulltext/ED395287.pdf

Taylor, V., Ashelford, S., Fell, P. L., & Goacher, P. J. (2015). Biosciences in nurse education: Is the curriculum fit for practice? Lecturers' views and recommendations from across the UK. *Journal of Clinical Nursing*, *24*(19–20), 2797–2806. https://doi.org/10.1111/jocn.12880

Thalluri, J., & Penman, J. (2020). Teaching science with impact using the lectorial approach. *Journal of College Science Teaching*, *50*(1), 36–42. https://www.jstor.org/stable/27119228

Thompson, R. A., & Zamboanga, B. L. (2004). Academic aptitude and prior knowledge as predictors of student achievement in introduction to psychology. *Journal of Educational Psychology*, *96*(4), 778–784. https://doi.org/10.1037/0022-0663.96.4.778

Timmins, F. (2008). Take time to facilitate self-directed learning. *Nurse Education in Practice*, *8*(5), 302–305. https://doi.org/10.1016/j.nepr.2008.02.004

Tock, J. L., & Moxley, J. H. (2016). A comprehensive reanalysis of the metacognitive self-regulation scale from the MSLQ. *Metacognition and Learning*, *12*(1), 79–111. https://doi.org/http://dx.doi.org/10.1007/s11409-016-9161-y

Toothaker, R., & Taliaferro, D. (2017). A phenomenological study of millennial students and traditional pedagogies. *Journal of Professional Nursing*, *33*(5), 345–349. https://doi.org/10.1016/j.profnurs.2017.01.004

Torrance, E. P., & Mourad, S. (1978). Self-directed learning readiness skills of gifted students and their relationship to thinking creatively about the future. *Gifted Child Quarterly*, *22*(2), 180–186. https://doi.org/10.1177/001698627802200211

Tough, A. M. (1967). Learning without a teacher: A study of tasks and assistance during adult self-teaching projects. *Educational Research Series; 3*, 92.

Townsend, J. (1990). Teaching/learning strategies. *Nursing Times*, *86*(23), 66–68. http://www.ncbi.nlm.nih.gov/pubmed/2359704

Tuckman, B. W. (2003). The effect of learning and motivation strategies training on college students achievement. *Journal of College Student Development*, *44*(3), 430–437. https://doi.org/10.1353/csd.2003.0034

Turunen, H., Taskinen, H., Voutilainen, U., Tossavainen, K., & Sinkkonen, S. (1997). Nursing and social work students' initial orientation towards their studies. *Nurse Education Today*, *17*(1), 67–71. https://doi.org/10.1016/S0260-6917(97)80082-2

Tytler, R. (2020). STEM Education for the Twenty-First Century. In J. Anderson & Y. Li (Eds.), *Integrated approaches to STEM education: An International perspective* (pp. 21–43). Springer Nature. https://doi.org/10.1007/978-3-030-52229-2_3

UNESCO. (2022). Beyond Limits. New Ways to Reinvent Higher Education. . *Documento Encargado*

Para La Conferencia Mundial de Educación Superior 18-20 de Mayo de 2022., *May*, 1–40.

Usher, E. L., & Schunk, D. H. (2018). Social cognitive theoretical perspective of self-regulation. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (Second, pp. 19–35). Routledge. https://doi.org/10.4324/9781315697048-2

Van Hecke, A., Duprez, V., Pype, P., Beeckman, D., & Verhaeghe, S. (2020). Criteria for describing and evaluating training interventions in healthcare professions – CRe-DEPTH. *Nurse Education Today*, *84*(August 2019), 104254. https://doi.org/10.1016/j.nedt.2019.104254

Virtanen, V., & Lindblom-Ylänne, S. (2010). University students' and teachers' conceptions of teaching and learning in the biosciences. *Instructional Science*, *38*(4), 355–370. https://doi.org/10.1007/s11251-008-9088-z

Vygotsky, L. . (1980). *Mind in society: The development of higher psychological processes.* Harvard University Press.

Weinstein, C. E. (1982). Learning strategies: The metacurriculum. *Journal of Developmental & Remedial Education*, *5*(2), 6.

Weinstein, C. E. (1989). Helping students develop strategies for effective learning. *Educational Leadership*, *46*(4), 17–19. https://www.researchgate.net/publication/265034514

Weinstein, C. E., Husman, J., & Dierking, D. R. (2000). Self-regulation interventions with a focus on learning strategies. In Monique Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 727–747). Academic Press. https://doi.org/10.1016/B978-012109890-2/50051-2

Weinstein, C. E., Jung, J., & Acee, T. W. (2010). Learning strategies. In *International Encyclopedia of Education* (pp. 323–329). https://doi.org/10.1016/B978-0-08-044894-7.00497-8

Weinstein, C. E., & Mayer, R. E. (1983). The teaching of learning strategies. *Innovation Abstracts*, *5*(32), 3–4. http://files.eric.ed.gov/fulltext/ED237180.pdf

Weinstein, C. E., & Meyer, D. K. (1991). Cognitive learning strategies and college teaching. In R. J. Menges & M. D. Svinicki (Eds.), *New Directions for Teaching and Learning.* (Vol. 45, Issue Spring, pp. 15–26). Jossey Bass Inc.

Weinstein, C. E., Palmer, D. R., & Acee, T. W. (2002). Learning and study strategies inventory LASSI third edition user's manual 3rd Edition. *H&H Publishing Company, Inc.*, 1–55. www.hhpublishing.com

Whyte, D. G., Madigan, V., & Drinkwater, E. J. (2011). Predictors of academic performance of nursing and paramedic students in first year bioscience. *Nurse Education Today*, *31*(8), 849–854. https://doi.org/10.1016/j.nedt.2010.12.021

Wiley, K. (1983). Effects of a self-directed: Learning project and preference for structure on self-directed learning readiness. *Nursing Research*, *32*(3), 181–185. https://doi.org/10.1097/00006199-198305000-00011

Wilke, R. R. (2003). The effect of active learning on student characteristics in a human physiology course for nonmajors. *Advances in Physiology Education*, *27*(1–4), 207–223. https://doi.org/10.1152/advan.00003.2002

Williamson, S. N. (2007). Development of a self-rating scale of self-directed learning. *Nurse Researcher*, *14*(2), 66–83. https://doi.org/https://doi.org/10.7748/nr2007.01.14.2.66.c6022

Winne, P. H. (1995). Self-regulation is ubiquitous but its forms vary with knowledge. *Educational Psychologist*, *30*(4), 223–228. https://doi.org/10.1207/s15326985ep3004_9

Winne, P. H. (2013). Learning strategies, study skills and self-regulated learning in post-secondary education. In M. B. Paulsen (Ed.), *Higher Education: Handbook of Theory and Research Vol XXVIII* (pp. 377–403). Springer Science & Business Media. https://doi.org/10.1007/978-94-007-5836-0

Winne, P. H., & Hadwin, A. F. (1998). Studying as self-regulated learning. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Metacognition in educational theory and practice*. Routledge. https://doi.org/10.4324/9781410602350

Wong, F. M. F., Tang, A. C. Y., & Cheng, W. L. S. (2021). Factors associated with self-directed learning among undergraduate nursing students: A systematic review. *Nurse Education Today*, *104*(June), 104998. https://doi.org/10.1016/j.nedt.2021.104998

Wong, J., & Wong, S. (1999). Contribution of basic sciences to academic success in nursing education. *International Journal of Nursing Studies*, *36*(4), 345–354. https://doi.org/10.1016/S0020-7489(99)00032-2

World Health Organisation. (2020, March 11). *WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020 [Press release]*. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-COVID-19---11-march-2020

Yang, C., Shanks, D. R., Zhao, W., Fan, T., & Luo, L. (2023). Frequent quizzing accelerates classroom learning empirical findings on test-enhanced learning, underemployment of test-enhanced learning and potential concerns about quizzing. In C. E. Overson, C. M. Hakala, L. L. Kordonowy, & V. A. Benassi (Eds.), *In their own words: What scholars and teachers want you to know about why and how to apply the science of learning in your academic setting* (pp. 252–262). American Psychological Association. https://scholars.unh.edu/faculty_pubs/1598/

Zhao, N., Wardeska, J. G., McGuire, S. Y., & Cook, E. (2014). Metacognition: An effective tool to promote success in college science learning. *Journal of College Science Teaching*, *43*(4), 48–54. https://www.jstor.org/stable/43632012

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary Educational Psychology*, *11*(4), 307–313. https://doi.org/10.1016/0361-476X(86)90027-5

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, *81*(3), 329–339. https://doi.org/10.1037/0022-0663.81.3.329

Zimmerman, B. J. (1998). Academic studying and the development of personal skill : A self-regulatory perspective. *Educational Psychologist*, *33*(2–3), 73–86. https://doi.org/10.1080/00461520.1998.9653292

Zimmerman, B. J. (2000a). Attaining self-regulation: A social cognitive perspective. In Monique Boekaerts, P. R. Pintrich, & M. Zeider (Eds.), *Handbook of Self-Regulation* (p. 783). Academic Press. https://doi.org/10.1016/B978-0-12-109890-2.X5027-6

Zimmerman, B. J. (2000b). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology*, *25*(1), 82–91. https://doi.org/10.1006/ceps.1999.1016

Zimmerman, B. J. (2001). Theories of self-regulated learning and academic acheivement: An overview and analysis. In B. J. Zimmerman & D. H. Schunk (Eds.), *Self-regulated learning and academic achievment. Theoretical Perspectives*. Taylor & Francis Group. https://doi.org/10.4324/9781410601032-1

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, *41*(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2

Zimmerman, B. J. (2013). From cognitive modeling to self-regulation: A social cognitive career path. *Educational Psychologist*, *48*(3), 135–147. https://doi.org/10.1080/00461520.2013.794676

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: the role of self-efficacy beliefs and personal goal-setting. *American Educational*

Research Journal, *29*(3), 663–676. https://doi.org/Doi 10.2307/1163261

Zimmerman, B. J., & Martinez-Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal*, *23*(4), 614–628. https://doi.org/10.3102/00028312023004614

Zimmerman, B. J., & Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology*, *80*(3), 284–290. https://doi.org/10.1037/0022-0663.80.3.284

Zimmerman, B. J., & Moylan, A. R. (2009). Self-regulation: Where metacognition and motivation intersect. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Handbook of Metacognition in Education*. https://doi.org/10.4324/9780203876428.ch16

Zuffianò, A., Alessandri, G., Gerbino, M., Luengo Kanacri, B. P., Di Giunta, L., Milioni, M., & Caprara, G. V. (2013). Academic achievement: The unique contribution of self-efficacy beliefs in self-regulated learning beyond intelligence, personality traits, and self-esteem. *Learning and Individual Differences*, *23*(1), 158–162. https://doi.org/10.1016/j.lindif.2012.07.010

Appendix A – Ethics Approval

This administrative form has been removed

Approval_Form_H

Printed on 14 Feb 2019

Informed Consent Form at the Beginning of the Online Survey

Motivated Strategies for Learning Questionnaire (MSLQ)

INFORMATION FOR PARTICIPANTS

You are invited to take part in a research project about motivation and strategies for learning of students enrolled in BM1111. The aim of the study is to develop teaching techniques to assist students to succeed in both BM1111 and in further study in the Health Sciences. The study is being conducted by Ms Vicki Dunk and will contribute to the research degree of Doctor of Philosophy at James Cook University.

As part of the study, you will be asked to complete this questionnaire at the beginning and again at the end of the semester. The two surveys will be matched to see what changes occur. Your responses will also be matched to your overall achievement in BM1111 and your first year anatomy and physiology subject, eg BM1031, BM1041, BM1051, BM1061 (if applicable). This matching will occur using a unique identifying number assigned to your answers. The Principal Researcher will not know who has completed the survey and who has not.

The benefit to you of completing the survey is the insight you will receive into your own learning preferences and where you might make improvements in the future.

YOUR PARTICIPATION IS VOLUNTARY AND NOT RELATED IN ANY WAY TO YOUR GRADE IN THIS CLASS. You may withdraw from the study at any time.

Your responses will be DE-IDENTIFIED and will be STRICTLY CONFIDENTIAL. The data from the study will be used in research publications and reports (PhD thesis and educational journal articles). You will not be identified in any way in these publications.

DE-IDENTIFICATION PROCEDURE
Your student number will be removed and replaced with a unique identifying number before the data goes to the Principal Investigator.
Your jc number will be used to match your preferences to your mark. This will be a two-person procedure to maintain your anonymity, each person will only have access to half of the identifying information. For example, the Principal Investigator will only have access to the unique identifying number and the survey results, while the Supervisor will have access to the unique identifying number, your jc number and your subject mark, but not your survey results. The Supervisor will replace your jc number on your mark with the unique identifying number before giving your mark to the Principal Investigator.

The attached questionnaire asks you about your study habits, your learning skills and your motivation for study in this course. THERE ARE NO RIGHT OR WRONG ANSWERS TO THIS QUESTIONNAIRE. We want you to respond to the questionnaire as accurately as possible, reflecting your own attitudes and behaviours in this subject. Your answers to this questionnaire will be analysed by computer and you will receive an individual report. Additionally, the responses of the class as a whole will be used to tailor the subject to class needs.

If you would like to be involved in this study please proceed with the questionnaire.

If you have any questions about the study, please contact:

Principal Investigator:
Ms Vicki Dunk
College of Public Health, Medical and Veterinary Sciences
James Cook University
Phone:
Email: Vicki.Dunk@jcu.edu.au

Supervisor:
Name: A/Prof Helen Boone
College of Arts, Society and Education
James Cook University
Phone:

Supervisor:
Name: Dr Tanya Doyle
College of Arts, Society and Education
James Cook University
Phone:
Email: Tanya.Doyle@jcu.edu.au

Supervisor:
Name: Dr Pam Megaw
College of Public Health, Veterinary and Medical Sciences
James Cook University
Phone:
Email: Pam.Megaw@jcu.edu.au

Thank you for your cooperation.

If you have any concerns regarding the ethical conduct of the study, please contact:
Human Ethics, Research Office
James Cook University, Townsville, Qld, 4811
Phone: (07) 4781 5011 (ethics@jcu.edu.au)

NEXT

Information Sheet - Interview

PROJECT TITLE: Metacognition and self-regulated learning strategy use of Nursing and Allied Health students in biosciences.

INFORMATION FOR PARTICIPANTS

You are invited to take part in a research project about the use of various study strategies by allied health students when undertaking studies in bioscience (e.g., anatomy and physiology). The project aims to uncover skills and preferences regarding studying at a deep or surface level. The study is being conducted by **Vicki Dunk** and will contribute to the **Doctor of Philosophy** at James Cook University.

DESCRIPTION OF PROTOCOLS

If you agree to be involved in the study, you will be asked to complete an interview of approximately 20 minutes. The interview will be conducted by a research assistant. The interview will be recorded, and a transcript produced for analysis. Any summary interview content, or direct quotations from the interview, that are made available through academic publication will be anonymized so that you cannot be identified, and care will be taken to ensure that other information in the interview that could identify you is not revealed.

Taking part in this study is completely voluntary and you can stop taking part in the study at any time without explanation or prejudice.

Your responses and contact details will be strictly confidential. The summary data from the study will be used in research publications and reports **(journal articles, theses)**. You will not be identified in any way in these publications.

If you have any questions about the study, please contact:

Principal Investigator: Vicki Dunk
College: College of Arts, Society and Education
James Cook University
Phone:
Email: Vicki.Dunk@jcu.edu.au

Supervisor: Dr Helen Boon
College: College of Arts, Society and Education
James Cook University
Phone:
Email: Helen.Boon@jcu.edu.au

If you have any concerns regarding the ethical conduct of the study, please contact:
Human Ethics, Research Office
James Cook University, Townsville, Qld, 4811
Phone: (07) 4781 5011 (ethics@jcu.edu.au)

Informed Consent Form - Interview

PRINCIPAL INVESTIGATOR: Vicki Dunk
PROJECT TITLE: Metacognition and self-regulated learning strategy use in Allied Health students in biosciences
COLLEGE: College of Arts, Society and Education

I understand the aim of this research study is to investigate the use of various study strategies by allied health students when undertaking studies in bioscience (eg anatomy and physiology). I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written information sheet to keep.

I understand that my participation will involve participating in an interview and I agree that the researcher may use the results as described in the information sheet.

I acknowledge that:

- taking part in this study is voluntary and I am aware that I can stop taking part in it at any time without explanation or prejudice and to withdraw any unprocessed data I have provided;
- that any information I give will be kept strictly confidential and that no names will be used to identify me with this study without my approval

☐ I consent to being interviewed and I consent to the interview being recorded

Name: *(printed)*	
Signature:	**Date:**

Appendix B – Motivated Strategies for Learning Questionnaire

Table B-1: Demographic Questions for the Intervention Cohort

Question	Response options	Included in Phase
jcnumber (for matching)	Free response	1,2,3
Please indicate which campus you are attending for BM1111	Townsville Cairns	2
Sex:	Male Female Prefer not to answer Other	1,2
Age:	0-19, 20-24, 25-29, 30-34, 35-39, 40+	1,2,3
Are you the first in your family to attend university?	Y/N	1,2,3
Have you undertaken university study before?	Y/N	2
How many subjects are you taking this semester?	1/2/3/4	2,3
What field of study are you aiming to go into? (e.g., nursing, biomedical science etc)	Free response	2,3
How many hours a week do you study for this subject (not including lectures and workshops)?	Free response	1,2,3
How many hours per week do you work for pay?	Free response	1,2,3
Have you completed year 12 or equivalent?	Yes, I have an ATAR or equivalent Yes, but I did not receive an ATAR or equivalent No	2
If you answered 'Yes' above. Did you complete biology and/or chemistry in year 12?	Biology Chemistry Both Neither	2

Table B- 2: Motivation Subscales

Item		Scale
1	In a class like this, I prefer course material that really challenges me so I can learn new things	Intrinsic
2	If I study in appropriate ways, then I will be able to learn the material in this subject	Control Beliefs
3	When I take a test I think about how poorly I am doing compared with other students	Test Anxiety
4	I think I will be able to use what I learn in this subject in other subjects	Task Value
5	I believe I will receive an excellent grade in this class	Self-efficacy
6	I'm certain I can understand the most difficult material presented in the readings for this subject	Self-efficacy
7	Getting a good grade in this class is the most satisfying thing for me right now	Extrinsic
8	When I take a test I think about items on other parts other test I can't answer	Test Anxiety
9	It is my own fault if I don't learn the material in this subject	Control Beliefs
10	It is important for me to learn the subject material in this class	Task Value
11	The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade	Extrinsic
12	I'm confident I can understand the basic concepts taught in this subject	Self-efficacy
13	If I can, I want to get better grades in this class than most of the other students	Extrinsic
14	When I take tests, I think of the consequences of failing	Test Anxiety
15	I'm confident I can understand the most complex material presented by the instructor in this subject	Self-efficacy
16	In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn	Intrinsic
17	I am very interested in the content area of this subject	Task Value
18	If I try hard enough, then I will understand the subject material	Control Beliefs
19	I have an uneasy, upset feeing when I take an exam	Test Anxiety
20	I'm confident I can do an excellent job on the assignments and tests in this subject	Self-efficacy
21	I expect to do well in this class	Self-efficacy
22	The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible	Intrinsic
23	I think the subject material in this class is useful for me to learn	Task Value
24	When I have the opportunity in this class, I choose assignments that I can learn from even if they don't guarantee a good grade	Intrinsic
25R	If I don't understand the subject material, it is because I didn't try hard enough	Control Beliefs
26	I like the subject matter of this subject	Task Value
27	Understanding the subject matter of this subject is very important to me	Task Value
28	I feel my heart beating fast when I take an exam	Test Anxiety
29	I'm certain I can master the skills being taught in this class	Self-efficacy
30	I want to do well in this class because it is important to show my ability to my family, friends, employers, or others	Extrinsic

31	Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class	Self-efficacy

Table B-3: Learning Strategy Subscales

Item		Scale
32	When I study the readings for this subject, I outline the material to help me organise my thoughts	Organisation
33R	During class time I often miss important point because I'm thinking of other things	Metacognitive Self-regulation
34	When studying for this subject, I often try to explain the materials to a classmate or a friend	Peer Learning
35	I usually study in a place where I can concentrate on my subject work	Time and Environment
36	When reading for this subject, I make up questions to help focus my reading	Metacognitive Self-regulation
37R	I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do	Effort Regulation
38	I often find myself questioning things I hear or read in this subject to decide if I find them convincing	Critical Thinking
39	When I study for this class, I practice saying the material to myself over and over	Rehearsal
40R	Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone	Help Seeking
41	When I become confused about something I'm reading for this class, I go back and try to figure it out	Metacognitive Self-regulation
42	When I study for this subject, I go through the readings and my class notes and try to find the most important ideas	Organisation
43	I make good use of my study time for this subject	Time and Environment
44	If subject materials are difficult to understand, I change the way I read the material	Metacognitive Self-regulation
45	I try to work with other student from this class to complete the subject assignments	Peer Learning
46	When studying for this class, I read my class notes and the course readings over and over again	Rehearsal
47	When a theory, interpretation, or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence	Critical Thinking
48	I work hard to do well in this class even if I don't like what we are doing	Effort Regulation
49	I make simple charts, diagrams, or table to help me organise subject material	Organisation
50	When studying for this subject, I often set aside time to discuss the subject material with a group of students from the class	Peer Learning
51	I treat the subject material as a starting point and try to develop my own ideas about it	Critical Thinking
52R	I find it hard to stick to a study schedule	Time and Environment
53	When I study for this class, I pull together information from different sources such as lectures, reading and discussions	Elaboration

54	Before I study new course material thoroughly, I often skim it to see how it is organised	Metacognitive Self-regulation
55	I ask myself questions to make sure I understand the material I have been studying in this class	Metacognitive Self-regulation
56	I try to change the way I study in order to fit the subject requirements and instructor's teaching style	Metacognitive Self-regulation
57R	I often find that I have been reading for class but don't know what it was all about	Metacognitive Self-regulation
58	I ask the instructor to clarify concepts I don't understand well	Help Seeking
59	I memorise key words to remind me of important concepts in this class	Rehearsal
60R	When course work is difficult, I give up or only study the easy parts	Effort Regulation
61	I try to think through a topic and decide what I am supposed to learn form it rather than just reading it over when studying	Metacognitive Self-regulation
62	I try to relate ideas in this subject to those in other subjects whenever possible	Elaboration
63	When I study for this subject, I go over my class notes and make an outline of important concepts	Organisation
64	When reading for this class, I try to relate the material to what I already know	Elaboration
65	I have a regular place set aside for studying	Time and Environment
66	I try to play around with ideas of my own related to what I am learning in this subject	Critical Thinking
67	When I study for this subject, I write brief summaries of the main ideas from the readings and the concepts from the lectures	Elaboration
68	When I can't understand the material in this subject, I ask another student in the class for help	Peer Learning
69	I try to understand the material in this class by making connections between the readings and the concepts from the lectures	Elaboration
70	I make sure I keep up with the weekly readings and assignments for this subject	Time and Environment
71	Whenever I read or hear and assertion or conclusion in this class, I think about possible alternatives	Critical Thinking
72	I make lists of important terms for this subject and memorise the list	Rehearsal
73	I attend this class regularly	Time and Environment
74	Even when subject materials are dull and uninteresting, I manage to keep working until I finish	Effort Regulation
75	I try to identify students in this class whom I can ask for help if necessary	Help Seeking
76	When studying for this subject I try to determine which concepts I don't understand well	Metacognitive Self-regulation
77R	I often find that I don't spend very much time on this subject because of other activities	Time and Environment
78	When I study for this class, I set goals for myself in order to direct my activities in each study period	Metacognitive Self-regulation
79	If I get confused taking notes in class, I make sure I sort it out afterwards	Metacognitive Self-regulation

80R	I rarely find time to review my notes or readings before an exam	Time and Environment
81	I try to apply ideas from subject readings in other class activities such as lectures and discussion	Elaboration

Note. The word “course” has been replaced with “subject” in some items because the word “course” means the higher level program at this university and the MSLQ is designed to be used at the lower level. Adapted from “A manual for the use of the motivated strategies for learning questionnaire (MSLQ)” by P. Pintrich, D. Smith, T. Garcia, W.J McKeachie, 1991, National Center for Research to Improve Postsecondary Teaching and Learning. (https://files.eric.ed.gov/fulltext/ED338122.pdf).

Appendix C – MSLQ Summary Data

Appendix C

Summary of Raw Data from the Motivated Strategies for Learning Questionnaire from Each Phase of the Study

This appendix contains the summary raw data from the Motivated Strategies for Learning Questionnaire from each of the three phases of the investigation (Figure C-1). A table showing the meaning and coding of each of the demographic variables is also included (Table C-1).

The Ethics approval does not allow for the verbatim transcripts of the interviews and open-ended questions to be included, as per the information provided to the students at the time of data collection (see **Appendix A**).

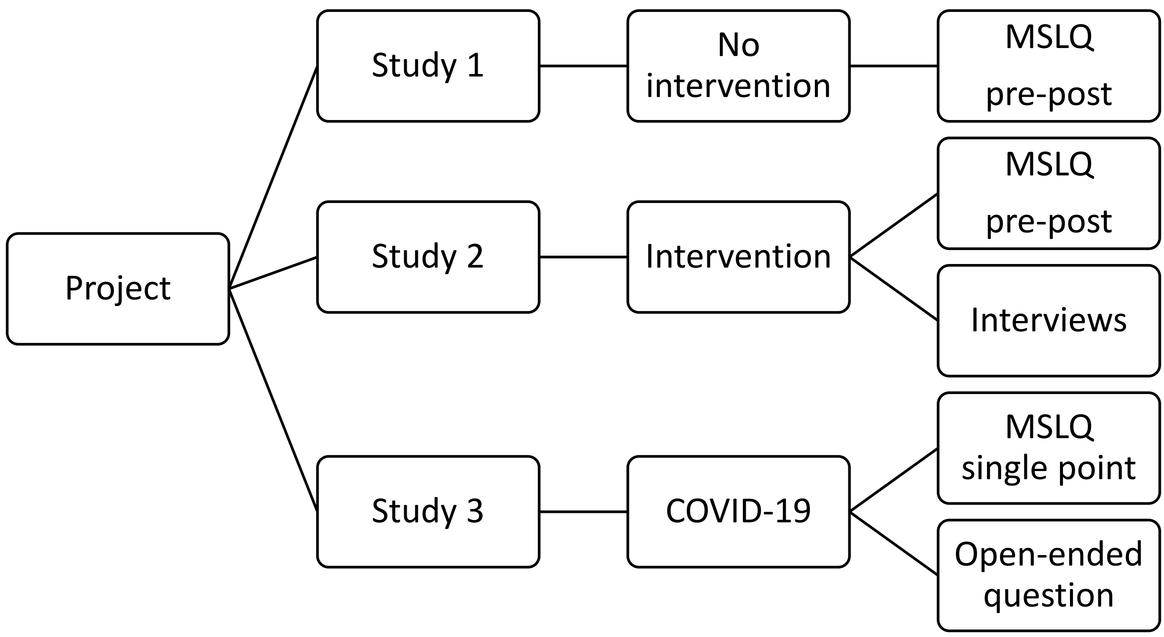

Figure C-1: Data collection summary

Table C-1: Coded demographic variables

Variable name	Description/Question	Value	Meaning
Time	Time when questionnaire was opened	1	Pre = beginning of semester
		2	Post = end of semester
Matched	Used to differentiate the matched pre-post pairs	0	Pre-survey, no match
		1	Pre-survey with match
		2	Post-survey with match
		3	Post-survey, no match
Age	Age of participant	1	<19
		2	20-24
		3	25-29
		4	30-34
Sex	Sex of participant	1	Female
		2	Male
		3	Prefer not to say
First in Family	Are you the first in your family to attend university?	1	Yes
		2	No
Previous Uni	Have you undertaken university study before?	1	Yes
		2	No
Campus	Which campus are you on?	1	Townsville
		2	Cairns
Grade	Based on the final mark	1	High Distinction >85
		2	Distinction >75 and <85
		3	Credit >65 and <75
		4	Pass >50
		5	Not Satisfactory <50
Subject	Which of the anatomy and physiology subjects offered by the university are you undertaking?	1	Nursing
		2	Occupational therapy
		3	Physiotherapy
		4	Speech Pathology
		5	Sports and exercise science
		6	Biomedicine
		7	Pharmacy
Field of Study	What field of study are you aiming to go into? Free response	0	Unsure
		1	Nursing
		2	Biomedicine
		3	Occupational therapy
		4	Speech pathology
		5	Pharmacy
		6	Sports and exercise science
		7	Physiotherapy
		8	Psychology
		9	Medical laboratory science
		10	Medicine
		11	Dentistry
		12	Science
BM1111	Completed the subject BM1111	1	Yes, 2019
		2	No
		3	Yes, 2018
Diploma	Students who are enrolled in the diploma	1	Yes
		2	No
Year 12	Have you completed year 12?	1	Yes
		2	No
ATAR	Student's ATAR completion status	1	Year 12 with ATAR

		2	Year 12 no ATAR
		3	Did not complete Year 12
HSSci	Which Year 12 science	0	Neither
		1	Biology
		2	Chemistry
		3	Both
Science	Completed any Year 12 science	1	Yes
		2	No
Biology	Completed Year 12 biology	1	Yes
		2	No
Chemistry	Completed Year 12 chemistry	1	Yes
		2	No
		2	No
COVID	Do you feel that your approach to studying, or the strategies that you use to study your ANATOMY & PHYSIOLOGY subject have changed as a result of the transition of remote and online learning?	1	Yes
		2	No

Table C-2: Demographic data of participants from Phase 1

Time	Matched	ID	Final Mark	Grade	Subject	Nursing	Sex	Age	First In Family	BM1111	Previous Uni	Num Subjects	Study Hours	Work Hours
1	1	1	61.21	4	1	1	1	4	2	2	1	3	15	8
2	2	1	61.21	4	1	1	1	4	2	1	1	3	4	30
1	3	2	76.00	3	3	2	2	4	1	2	1	4	20	10
1	1	3	78.45	2	1	1	1	2	1	2	1	3	3	10
2	2	3	78.45	2	1	1	1	2	1	2	1	3	10	0
1	1	4	85.50	1	1	1	1	2	2	2	1	4	12	20
2	2	4	85.50	1	1	1	1	2	2	2	1	4	7	16
1	1	5	87.38	1	1	1	1	2	2	2	1	4	4	0
2	2	5	87.38	1	1	1	1	2	2	2	1	4	10	0
1	0	6	84.20	2	2	2	1	2	2	1	1	4	10	4
1	0	7	76.23	2	5	2	1	5	2	2	2	4	25	9
1	0	8	70.00	3	1	1	1	3	2	2	1	3	30	0
1	1	9	88.21	1	1	1	1	2	2	1	1	2	5	40
2	2	9	88.21	1	1	1	1	4	2	2	1	3	5	0
1	1	10	50.69	4	1	1	1	2	1	2	1	3	10	10
2	2	10	50.69	4	1	1	1	2	1	1	1	3	6	0
1	0	11	47.41	5	1	1	1	3	1	2	1	3	30	30
1	0	12	73.40	3	2	2	1	1	1	2	1	3	10	0
1	1	13	88.55	1	1	1	1	4	1	1	1	2	4	28
2	2	13	88.55	1	1	1	1	5	1	1	1	2	5	30
1	1	14	74.57	3	1	1	1	6	1	1	1	4	7	30
2	2	14	74.57	3	1	1	1	6	1	1	1	4	6	0
1	0	15	72.27	3	1	1	1	1	1	2	2	4	9	14
1	0	16	85.11	1	1	1	1	4	1	2	2	2	12	22
1	1	17	48.10	5	2	2	1	5	1	1	1	4	5	10
2	2	17	48.10	5	2	2	1	5	1	2	2	4	8	20
1	0	18	61.74	4	1	1	1	3	1	2	2	2	2	30
1	0	19			5	2	2	4	1	1	1	4	5	8
1	1	20	85.13	1	1	1	1	1	2	2	1	3	10	30
2	2	20	85.13	1	1	1	1	1	2	2	1	3	5	35
1	0	21	74.56	3	1	1	1	1	1	2	1	4	10	10
1	0	22			2	2	1	1	2	2	2	4	15	10
2	3	23	74.76	3	1	1	1	1	2	2	1	4	3	15
1	0	24			5	2	2	1	1	2	2	4	6	10
1	1	25	54.20	4	1	1	1	1	1	2	1	4	8	0
2	2	25	54.20	4	1	1	1	1	1	2	1	4	5	0
2	3	26	71.43	3	1	1	1	1	1	1	1	4	10	5
1	1	27	70.43	3	1	1	1	1	1	2	1	2	20	10

Time	Matched	ID	Final Mark	Grade	Subject	Nursing	Sex	Age	First In Family	BM1111	Previous Uni	Num Subjects	Study Hours	Work Hours
2	2	27	70.43	3	1	1	1	1	1	2	1	2	16	2
2	3	28	76.29	2	1	1	1	4	2	2	2	2	20	8
2	3	29	70.09	3	1	1	1	6	2	2	1	3	20	10
1	1	30	80.54	2	1	1	1	6	1	1	1	4	10	0
2	2	31	80.54	2	1	1	1	6	2	1	1	4	40	0
1	1	32	81.40	2	1	1	1	1	2	2	1	4	3	10
2	2	32	81.40	2	1	1	1	1	2	2	1	4	5	12
1	0	33	89.13	1	1	1	2	1	2	2	1	4	5	6
1	0	34	86.60	1	3	2	1	1	2	2	2	4	15	20
1	0	35	89.68	1	1	1	1	1	1	2	2	4	5	15
1	0	36	49.74	5	1	1	1	1	1	2	2	4	12	16
1	0	37	50.34	4	1	1	1	1	1	1	1	4	10	20
2	3	38	53.44	4	1	1	1	2	1	1	1	4	15	38
1	0	39	56.58	4	1	1	1	4	2	2	2	3	8	40
1	0	40	78.44	2	1	1	1	2	2	2	2	4	8	7
1	1	41	86.38	1	1	1	1	2	2	2	1	4	5	15
2	2	41	86.38	1	1	1	1	2	2	2	1	4	30	15
2	3	42	84.00	2	1	1	1	6	2	2	2	4	2	15
1	0	43	88.00	1	2	2	1	1	1	2	2	4	10	15
1	0	44			5	2	1	2	1	2	2	4	7	16
1	1	45	76.50	2	1	1	1	4	1	2	2	4	5	10
2	2	45	76.50	2	1	1	1	4	1	2	2	4	5	0
1	0	46	78.90	2	1	1	2	3	1	2	2	4	6	0
2	2	47	62.60	4	1	1	1	3	2	2	1	4	40	0
1	1	48	62.60	4	1	1	1	5	2	2	1	4	30	0
1	0	49	83.71	2	1	1	2	3	1	2	1	4	6	0
1	0	50	65.88	3	1	1	1	1	1	2	2	4	20	0
1	0	51			1	1	2	2	1	2	2	4	5	31
1	1	52	51.64	4	1	1	1	1	1	2	2	4	3	15
2	2	52	51.64	4	1	1	1	1	1	2	2	4	14	11
2	3	53	63.74	4	1	1	1	1	2	2	2	4	5	6
1	0	54	67.96	3	1	1	1	1	2	2	2	4	7	10
1	1	55	49.47	5	1	1	1	1	2	2	2	4	20	0
2	2	55	49.47	5	1	1	1	1	2	2	2	4	21	0
1	1	56	61.70	4	2	2	1	1	2	2	2	4	4	26
2	2	56	61.70	4	2	2	1	1	1	2	2	4	4	12
1	0	57	43.47	5	1	1	1	1	2	1	1	4	15	17
1	0	58	50.20	4	1	1	1	1	1	2	2	4	4	35
1	0	59	77.43	2	1	1	1	1	1	2	2	4	2	6
1	0	60	78.50	2	2	2	1	1	2	2	2	4	3	20
1	0	61	75.19	2	1	1	1	1	1	1	1	4	10	3
1	0	62	79.63	2	1	1	1	1	2	2	2	4	10	0

Time	Matched	ID	Final Mark	Grade	Subject	Nursing	Sex	Age	First In Family	BM1111	Previous Uni	Num Subjects	Study Hours	Work Hours
2	3	63	41.80	5	1	1	1	1	1	2	2	3	5	0
1	0	64	79.63	2	1	1	1	1	1	2	2	4	16	24
1	0	65	60.18	3	1	1	2	1	2	2	2	4	5	10
1	0	66	60.46	3	1	1	1	1	2	2	2	4	20	10
1	1	67	59.98	3	1	1	1	1	1	2	2	4	4	0
2	2	67	59.98	3	1	1	1	1	1	2	2	4	10	0
1	0	68	70.05	3	1	1	1	1	1	2	2	4	12	0
1	0	69	71.30	3	2	2	1	1	2	2	2	4	7	9
1	1	70	59.50	4	2	2	1	1	1	2	2	3	5	22
2	2	70	59.50	4	2	2	1	1	1	2	2	3	4	20
1	0	71	84.34	2	1	1	1	1	2	2	2	4	4	0
2	3	72	48.24	5	1	1	1	1	2	2	2	4	21	0
2	3	73	42.49	5	1	1	1	1	1	2	2	4	7	0
1	1	74			5	2	1	1	1	2	2	4	6	0
2	2	74			5	2	1	1	1	2	2	4	21	0
1	0	75	90.10	1	2	2	1	1	2	2	2	4	6	0
1	1	76			5	2	1	4	2	2	1	4	7	9
2	2	76			5	2	1	4	2	2	1	4	6	10
1	1	77	37.33	5	1	1	1	2	1	2	2	4	2	30
2	2	77	37.33	5	1	1	1	2	1	2	2	4	15	38
1	0	78	79.49	2	1	1	1	1	2	2	2	4	7	40
2	2	79	55.01	4	1	1	1	1	1	2	2	4	20	27
1	1	80	55.01	4	5	2	1	2	2	2	2	3	6	10
1	0	81	86.63	1	1	1	1	1	1	2	2	4	6	20
1	0	82	57.79	4	1	1	1	1	1	2	2	4	14	0
1	1	83	67.89	3	1	1	1	1	2	2	2	4	10	8
2	2	84	67.89	3	1	1	1	1	2	2	2	4	5	15
1	1	85	55.93	4	1	1	1	1	1	2	2	4	5	8
2	2	85	55.93	4	1	1	1	1	1	2	2	4	5	0
2	3	86	89.50	1	1	1	1	1	2	1	1	4	5	0
1	0	87	53.67	4	1	1	1	1	2	2	2	4	3	10
1	0	88	55.52	4	1	1	1	1	1	2	2	4	15	16
1	1	89	62.11	4	1	1	1	1	1	2	2	4	2	0
2	2	89	62.11	4	1	1	1	1	1	2	2	4	5	0
1	1	90	58.35	4	1	1	1	2	1	2	2	2	8	0
2	2	90	58.35	4	1	1	1	2	1	2	2	2	8	0
1	1	91	88.78	1	1	1	1	3	1	2	1	4	2	0
2	2	92	88.78	1	1	1	1	4	1	2	1	4	2	0
1	0	93	70.00	2	1	1	2	2	2	2	2	4	20	5
1	1	94	76.57	2	1	1	1	3	1	1	1	4	10	20
2	2	95	76.57	2	1	1	1	3	1	2	2	4	5	25

Table C-3: Motivated Strategies for Learning Questionnaire subscale means for participants from Phase 1

Matched	ID	Intrinsic	Extrinsic	Task Value	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognition	Effort Regulation	Environment	Help Seeking
1	1	5.5	4.8	6.4	6.0	5.3	5.4	6.3	5.7	5.0	5.7	5.0	5.4	4.3	5.3	6.0
2	1	5.0	4.0	5.2	5.5	4.4	5.0	5.5	5.0	4.8	5.3	4.2	4.6	4.5	4.3	4.3
3	2	6.3	3.8	7.0	6.5	4.8	5.2	4.0	3.3	3.0	2.7	4.0	4.1	6.3	4.8	2.0
1	3	5.3	7.0	6.2	6.5	3.5	4.6	5.0	4.5	5.0	4.3	3.6	3.1	6.3	3.9	3.8
2	3	7.0	7.0	7.0	6.8	6.8	6.4	6.8	6.8	7.0	7.0	7.0	6.0	4.3	4.9	5.3
1	4	5.5	5.5	5.6	5.5	4.3	4.0	5.0	5.2	5.3	5.3	4.6	4.7	5.3	5.3	4.5
2	4	7.0	6.5	7.0	6.8	4.9	6.2	6.5	7.0	7.0	4.3	6.0	5.9	7.0	6.9	5.5
1	5	5.0	6.8	5.8	5.5	5.3	6.2	6.3	6.3	6.5	6.7	4.6	4.8	4.8	5.8	4.3
2	5	5.5	6.5	6.7	5.8	6.4	6.0	5.8	6.3	6.0	7.0	4.8	5.8	4.5	5.9	4.5
0	6	4.8	4.5	6.8	5.0	3.3	5.8	4.8	6.3	6.0	2.0	2.6	4.0	6.3	6.3	2.5
0	7	4.8	7.0	7.0	6.8	6.9	1.6	6.5	5.7	6.3	6.0	5.2	4.5	7.0	5.6	4.8
0	8	3.5	7.0	6.6	5.0	4.3	4.8	3.5	5.7	4.0	2.0	2.6	3.8	6.3	3.9	4.0
1	9	6.8	6.8	7.0	6.5	5.1	5.4	5.5	4.0	3.3	5.0	1.6	4.3	6.0	4.3	5.8
2	9	5.8	5.8	5.8	5.8	6.0	3.4	5.8	5.8	5.3	3.0	6.0	5.8	5.8	5.5	3.3
1	10	1.3	1.0	2.0	2.8	4.1	1.4	1.0	1.2	1.5	1.0	1.0	2.0	3.3	3.1	2.0
2	10	4.5	4.5	6.0	5.0	5.4	5.8	4.3	3.7	4.3	3.3	3.8	4.1	4.8	3.6	3.3
0	11	4.5	4.3	5.6	4.5	4.3	4.4	3.5	3.7	3.8	3.3	3.8	3.7	4.3	4.5	3.8
0	12	6.5	7.0	6.8	6.8	6.1	6.6	6.3	5.8	6.8	6.0	5.2	4.8	5.0	5.8	4.5
1	13	4.0	6.0	5.2	5.0	4.9	3.8	3.0	3.5	3.3	4.0	2.8	2.9	6.0	4.6	5.8
2	13	5.3	5.8	5.7	6.0	5.3	5.2	4.0	4.0	3.8	3.7	2.8	3.9	5.0	4.5	4.8
1	14	5.0	4.8	6.4	5.5	4.6	6.4	4.5	4.5	4.0	5.3	1.8	4.3	6.8	6.5	6.0
2	14	4.5	4.0	7.0	6.3	4.3	2.8	6.0	5.3	5.3	5.3	3.6	4.8	6.0	6.3	5.3
0	15	4.8	6.3	6.0	5.5	4.0	6.0	4.3	4.8	4.3	4.0	5.0	3.9	4.0	4.5	3.5
0	16	4.8	4.8	5.8	5.3	4.3	5.6	7.0	6.2	6.0	5.0	2.8	5.2	7.0	6.6	4.8
1	17	4.8	5.3	7.0	5.8	5.3	7.0	4.5	5.3	5.3	6.0	3.8	5.8	7.0	5.9	5.5
2	17	4.8	6.5	6.8	6.3	2.8	7.0	6.3	6.0	3.5	5.0	2.6	4.9	6.5	4.9	5.8
0	18	5.5	4.3	6.4	6.0	5.1	4.0	5.3	4.5	6.3	3.3	3.2	4.3	5.5	4.1	5.5
0	19	4.0	4.3	5.0	5.3	4.1	2.6	3.3	4.5	4.0	3.7	3.2	4.1	5.0	4.8	4.8
1	20	5.5	6.8	7.0	7.0	4.5	6.8	6.3	6.7	6.3	1.7	4.4	5.3	6.3	6.1	2.5
2	20	4.3	6.8	6.7	6.8	5.1	5.6	6.0	5.3	4.5	3.7	2.8	4.8	4.8	4.6	3.3
0	21	5.5	5.3	5.8	6.3	5.0	6.0	4.0	4.5	5.5	3.0	4.6	4.1	5.5	5.1	4.5
0	22	4.0	5.3	5.6	6.0	4.6	6.8	6.3	5.8	6.3	4.3	4.8	4.3	5.3	5.5	4.3
3	23	4.5	6.0	6.2	6.3	5.3	2.6	5.0	5.7	5.5	4.7	2.4	5.1	6.3	5.9	6.3
0	24	5.8	6.3	6.6	6.8	4.9	6.2	3.3	3.2	3.3	3.3	3.0	3.3	4.3	5.1	3.5
1	25	5.3	7.0	6.8	7.0	4.0	7.0	4.3	4.7	3.8	3.3	2.0	4.3	2.5	4.8	4.8
2	25	5.0	6.0	6.8	7.0	4.5	4.4	6.3	6.8	6.3	4.7	3.8	5.6	5.3	5.1	5.0
3	26	2.3	2.8	3.2	2.5	2.5	3.0	3.0	3.0	3.3	4.3	2.8	3.4	3.8	3.8	3.5
1	27	4.3	5.0	5.2	6.0	4.3	4.8	3.3	3.8	3.8	4.7	3.4	3.4	5.0	5.5	5.3
2	27	5.3	6.5	6.2	6.8	5.1	4.8	6.0	5.2	4.8	6.0	4.8	5.8	4.8	5.8	5.8

Matched	ID	Intrinsic	Extrinsic	Task Value	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognition	Effort Regulation	Environment	Help Seeking
3	28	5.5	6.0	6.5	5.8	5.3	4.6	6.5	5.0	6.5	5.0	2.2	4.5	5.8	5.4	3.3
3	29	4.3	4.5	5.5	5.5	5.3	3.4	6.0	5.0	6.3	4.7	3.0	5.2	6.0	4.6	5.5
1	30	6.0	5.0	6.4	7.0	5.1	6.0	6.0	6.5	7.0	6.3	6.0	5.3	6.0	6.6	5.8
2	31	6.0	5.5	6.5	5.3	4.9	5.0	5.3	6.0	6.3	5.7	5.6	5.2	6.0	6.3	3.8
1	32	6.5	3.3	7.0	7.0	5.5	4.8	2.8	5.7	4.8	7.0	3.8	4.3	5.5	5.5	6.5
2	32	6.0	5.3	7.0	6.8	5.5	4.0	5.5	6.3	6.3	6.7	4.2	5.3	5.8	5.5	6.5
0	33	3.8	5.8	4.4	4.0	4.3	5.0	4.3	4.2	4.3	3.7	4.2	3.8	4.0	3.6	3.5
0	34	4.8	6.0	5.8	6.0	5.0	5.0	4.8	4.7	4.0	5.3	3.8	3.9	4.0	4.6	4.8
0	35	6.0	7.0	7.0	7.0	6.3	1.6	7.0	7.0	6.5	3.7	5.0	5.7	6.5	7.0	4.0
0	36	4.5	5.3	6.2	6.0	4.4	5.8	3.3	5.0	6.8	2.0	4.8	3.9	4.8	4.6	4.0
0	37	6.0	5.8	6.6	6.3	5.8	3.8	5.5	6.2	6.3	4.7	4.8	4.2	6.3	6.4	5.5
3	38	4.0	5.3	5.2	4.0	4.3	5.6	3.5	4.2	5.5	5.7	4.2	4.0	5.5	4.1	6.5
0	39	5.5	6.5	6.4	6.8	5.1	4.8	5.3	5.3	5.5	3.0	5.4	4.0	5.8	4.9	5.0
0	40	7.0	7.0	7.0	6.3	5.3	5.8	5.5	6.2	5.3	4.7	3.8	5.1	6.3	5.9	1.8
1	41	5.8	6.8	6.8	6.3	4.6	2.4	5.5	6.8	5.3	5.3	5.4	5.2	6.3	6.0	6.0
2	41	6.0	7.0	7.0	6.8	5.6	2.0	5.8	6.2	6.5	5.0	4.8	6.0	4.8	6.4	5.0
3	42	4.8	5.5	5.7	6.3	3.1	2.4	3.3	3.5	3.0	3.3	1.8	3.0	4.3	3.9	3.3
0	43	4.5	4.5	6.0	5.5	1.6	6.4	5.3	5.3	6.8	2.7	4.4	5.1	6.8	5.9	4.5
0	44	6.3	6.3	6.6	6.8	6.1	5.6	6.3	5.5	6.0	6.0	5.6	4.8	5.8	5.6	5.0
1	45	4.8	7.0	6.4	7.0	3.4	7.0	6.3	5.0	5.3	5.7	4.0	4.0	4.8	3.9	5.5
2	45	4.5	6.5	5.5	6.0	2.9	7.0	5.3	5.3	4.3	5.0	3.0	3.8	3.8	3.9	5.3
0	46	6.0	7.0	6.6	6.5	5.4	6.2	6.0	5.2	5.0	2.0	5.4	4.7	5.5	4.1	5.3
2	47	6.8	6.3	5.8	6.5	3.8	7.0	4.8	4.8	6.5	2.0	3.6	5.9	3.5	5.3	4.3
1	48	6.5	6.3	6.6	6.8	2.3	6.6	6.5	5.3	5.8	1.3	2.6	4.9	4.8	6.4	3.3
0	49	5.8	5.5	6.0	5.3	5.3	3.6	5.0	5.3	4.0	5.3	4.0	3.9	5.0	5.4	4.8
0	50	5.5	6.5	6.8	5.8	5.3	5.0	4.0	5.7	4.8	3.7	3.8	5.3	6.3	6.4	3.0
0	51	5.3	4.8	5.8	5.3	3.5	4.8	5.8	6.0	6.5	5.7	4.2	4.5	6.5	5.8	4.8
1	52	3.8	5.8	5.8	5.3	4.4	6.6	4.5	4.3	4.3	6.0	4.0	3.3	4.8	4.9	3.8
2	52	5.5	6.0	6.8	5.8	4.5	5.6	5.3	4.7	4.5	5.7	5.4	5.0	4.8	5.3	2.8
3	53	3.8	5.8	6.3	7.0	4.5	5.6	5.3	5.0	4.3	4.7	4.8	4.0	4.8	5.5	3.0
0	54	4.8	7.0	6.2	5.8	4.6	4.4	6.0	5.8	5.8	5.3	4.4	4.3	6.3	5.3	5.0
1	55	6.0	6.0	6.8	6.5	5.1	6.4	5.8	6.3	6.8	6.3	5.8	4.9	6.0	5.6	5.3
2	55	5.8	4.3	6.5	6.5	4.5	6.0	5.5	5.3	5.8	6.0	3.2	4.2	5.3	5.1	5.5
1	56	2.8	5.8	4.2	3.8	2.8	5.6	1.8	2.2	2.3	2.7	1.8	1.9	4.3	2.8	2.5
2	56	5.0	5.0	5.0	5.0	3.4	6.0	3.5	3.2	3.3	3.7	3.4	3.3	3.5	3.4	3.3
0	57	4.8	4.8	4.6	4.3	3.9	5.0	4.8	3.3	3.8	3.7	3.0	4.3	4.0	3.3	4.3
0	58	4.5	4.8	5.8	6.0	3.4	5.2	3.5	4.2	4.5	3.3	3.0	2.9	2.3	2.9	5.0
0	59	5.0	5.3	4.8	5.0	3.4	5.2	3.8	3.7	4.0	4.7	4.2	3.5	4.3	4.1	4.3
0	60	4.5	6.5	5.6	6.0	4.5	5.0	5.3	5.2	4.3	4.7	3.8	4.0	5.5	5.6	4.0
0	61	5.0	6.3	6.4	6.5	5.3	6.6	5.3	6.0	6.0	5.3	5.4	5.1	5.8	5.4	5.0
0	62	5.3	6.5	6.2	6.3	4.1	4.2	3.5	4.0	3.8	3.7	4.0	3.3	4.8	4.9	3.5

Matched	ID	Intrinsic	Extrinsic	Task Value	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognition	Effort Regulation	Environment	Help Seeking
3	63	4.3	5.8	4.8	5.8	2.8	5.2	4.0	3.5	3.8	3.3	3.0	3.8	3.8	4.4	2.8
0	64	5.5	5.3	4.8	5.0	5.0	4.6	4.0	4.2	4.8	3.7	2.8	3.8	5.5	5.3	3.8
0	65	5.3	4.3	5.8	6.5	6.5	3.4	3.0	6.3	4.8	4.7	4.8	4.5	6.5	6.1	4.3
0	66	4.3	5.5	6.6	4.8	4.5	5.6	4.3	4.8	4.8	2.3	3.2	3.9	4.5	5.1	3.3
1	67	3.5	5.8	5.4	4.8	2.9	4.8	3.0	4.2	2.8	1.3	3.0	3.8	4.8	3.1	3.0
2	67	3.3	6.3	4.8	4.5	3.0	5.4	5.0	3.5	4.8	2.7	2.6	4.3	5.5	5.5	3.5
0	68	4.8	7.0	7.0	6.3	6.0	3.8	7.0	7.0	7.0	3.7	4.8	6.0	7.0	7.0	6.5
0	69	4.3	6.3	6.0	4.8	2.6	6.2	6.3	5.0	6.3	5.7	4.0	4.3	6.3	6.4	3.8
1	70	5.5	6.5	6.4	5.8	4.1	6.0	4.8	5.7	5.8	5.7	5.4	4.8	5.5	5.5	3.8
2	70	3.8	4.5	5.5	5.0	3.5	5.6	4.8	5.5	5.8	4.3	4.2	4.7	5.0	4.8	3.8
0	71	5.0	6.8	5.8	5.8	5.3	4.4	5.5	4.8	5.0	2.7	4.2	4.3	6.3	5.8	3.0
3	72	4.5	5.0	6.3	6.3	2.9	4.8	3.5	3.5	3.8	3.7	2.4	2.5	3.3	2.9	4.3
3	73	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.7	4.0	3.5	3.0
1	74	4.8	5.3	6.4	5.0	5.0	4.2	6.3	5.7	5.8	4.7	3.8	5.1	5.8	5.6	4.5
2	74	4.5	4.5	6.5	4.8	4.3	4.8	5.5	5.2	5.8	3.7	3.2	4.6	5.0	4.9	3.8
0	75	5.0	4.3	6.6	5.5	4.0	4.6	4.0	7.0	6.3	3.3	4.0	4.2	6.8	5.6	2.5
1	76	5.3	6.5	6.6	4.5	5.0	5.8	4.5	5.5	5.8	3.7	3.0	3.8	5.8	5.5	3.8
2	76	4.0	5.8	6.2	6.3	5.4	4.4	4.5	5.0	6.3	3.0	2.6	4.6	5.5	5.3	4.5
1	77	3.5	7.0	6.6	5.5	3.3	7.0	4.3	2.8	2.5	3.7	2.0	3.3	4.3	3.3	5.8
2	77	5.0	7.0	5.2	4.5	2.3	7.0	3.0	3.0	2.8	4.7	3.2	2.9	3.0	3.4	2.5
0	78	4.8	7.0	6.8	6.5	6.8	2.6	5.8	5.7	6.3	5.3	5.2	5.0	6.0	6.0	5.0
2	79	2.8	3.5	3.5	3.8	3.1	2.8	3.3	2.8	2.8	3.3	1.8	3.6	4.8	4.4	3.3
1	80	5.5	7.0	6.4	6.8	4.3	5.0	5.5	6.3	6.5	4.3	6.0	5.2	6.8	6.3	3.3
0	81	5.3	5.3	7.0	6.3	4.6	6.0	7.0	6.2	5.8	3.3	1.6	3.3	6.3	6.4	3.3
0	82	4.5	4.5	6.0	5.3	4.5	2.4	5.5	3.5	3.8	4.3	2.4	3.3	4.5	6.0	3.0
1	83	5.3	4.0	5.8	6.5	4.4	5.0	4.8	5.3	4.0	3.7	5.0	4.3	2.5	3.0	1.3
2	84	4.0	3.5	5.8	5.8	2.8	4.8	5.5	6.2	5.5	5.3	3.8	3.9	3.5	3.3	1.3
1	85	3.8	6.0	5.0	5.5	2.5	5.6	3.3	4.0	4.0	2.0	2.8	3.7	3.5	4.4	2.8
2	85	3.0	5.5	5.5	5.5	2.3	6.0	4.0	3.8	3.3	2.0	2.4	3.0	3.8	4.6	2.3
3	86	5.8	5.8	7.0	6.5	6.9	1.0	6.3	7.0	5.5	2.7	6.0	6.1	7.0	7.0	3.3
0	87	5.0	5.0	6.0	6.8	4.5	6.6	4.5	4.3	5.0	4.0	4.4	3.9	4.0	4.1	3.8
0	88	5.0	6.3	6.6	6.0	4.9	5.2	4.0	4.2	4.5	5.0	3.4	3.5	4.3	4.4	4.8
1	89	2.8	5.3	6.6	6.0	3.0	5.0	2.3	2.5	2.8	2.7	1.6	2.6	5.0	4.1	4.3
2	89	3.5	5.8	7.0	7.0	2.0	5.4	1.8	2.7	3.3	3.3	1.2	2.2	1.0	3.4	4.0
1	90	4.3	4.8	4.0	5.0	3.5	3.8	5.5	4.7	4.3	4.0	3.8	4.5	4.8	4.4	3.0
2	90	4.3	5.5	4.5	5.3	2.8	5.4	4.3	3.7	4.3	3.7	4.2	3.7	3.0	3.6	4.0
1	91	5.3	5.3	6.8	7.0	6.1	4.4	4.5	5.7	4.0	3.0	4.2	4.6	4.5	4.0	4.0
2	92	5.5	6.8	6.2	7.0	6.0	4.4	5.0	6.7	6.0	5.3	5.4	5.5	5.0	4.9	5.8
0	93	5.0	6.3	5.8	5.5	5.8	3.6	5.5	5.0	4.3	4.3	3.2	4.3	4.0	3.9	2.0
1	94	4.5	5.8	6.4	5.8	4.5	6.6	6.8	6.2	6.3	6.3	4.2	4.8	5.3	5.1	5.8
2	95	5.3	4.5	5.5	6.0	5.3	6.2	6.0	6.2	5.8	6.3	4.2	5.7	5.3	5.4	6.0

Table C-4: Demographic data of participants from Phase 2

Time	matched	ID	Final Mark	Grade	Campus	Sex	Age	FIF	Diploma	Previous Study	Number of Subjects	Field of Study	Study hours pre	Study hours post	Work hours pre	ATAR	Yr12	Science	Biology	Chemistry	HSSci
1	0	80	63.7	2	2	1	1	2	1	1	3	6	30		25	1	1	2	2	2	0
1	0	101	87.9	5	2	2	2	1	1	1	4	11	10		20	1	1	2	2	2	0
1	0	84			2	2	2	1	1	2	4	7	12		20	3	2	2	2	2	0
1	0	97	76.7	4	2	1	1	2	1	2	3	4	4		25	1	1	1	2	2	2
1	1	91	79.9	4	2	1	1	2	1	2	2	3	4		10	2	1	2	2	2	0
1	0	103	70.0	3	2	1	3	1	1	2	3	1	10		0	2	1	2	2	2	0
1	1	98	76.3	4	2	1	1	2	1	2	3	1	4	2	0	1	1	2	2	2	0
1	0	99	65.1	3	2	1	1	1	1	2	3	1	5		15	2	1	2	2	2	0
1	1	96	82.0	4	2	1	1	2	1	2	4	2	10	8	0	1	1	1	1	2	1
1	0	94	89.6	5	2	2	4	2	1	1	3	11	6		24	3	2	2	2	2	0
1	0	90	52.8	2	2	2	2	2	1	1	4	1	6		20	2	1	2	2	2	0
1	0	83	75.8	4	2	1	2	2	1	2	2	12	8		12	3	2	2	2	2	0
1	0	87			2	2	4	1	1	2	3	2	8		24	3	2	2	2	2	0
1	0	88	34.1	1	2	2	2	1	1	2	2	0	10		15	2	1	2	2	2	0
1	1	93	90.4	5	2	2	4	2	1	2	2	1	20	15	30	1	1	2	2	2	0
1	0	102	17.9	1	2	1	1	1	1	1	2	1	10		30	3	2	1	1	1	3
1	0	95	29.1	1	2	1	1	1	1	2	3	1	3		6	1	1	1	1	2	1
1	0	79	58.0	2	2	1	2	2	1	2	1	1	6		32	1	1	1		2	1
1	0	104			2	1	2	2	1	2	4	1	30		10	3	2	2	2	2	0
1	0	86	62.1	2	2	1	1	1	1	1	3	1	4		10	1	1	1	1	2	1
1	1	1	72.7	3	1	2	3	2	1	1	4	0	12	6	20	1	1	2	2	2	0
1	1	2	83.3	4	1	1	2	2	1	2	4	2	50	30	8	1	1	1	1	1	3

Time	matched	ID	Final Mark	Grade	Campus	Sex	Age	FIF	Diploma	Previous Study	Number of Subjects	Field of Study	Study hours pre	Study hours post	Work hours pre	ATAR	Yr12	Science	Biology	Chemistry	HSSci
1	0	3	60.2	2	1	1	1	1	1	2	3	4	10		20	2	1	2	2	2	0
1	1	4	84.5	4	1	1	2	1	1	2	3	7	6	7	25	3	2	2	2	2	0
1	0	5	53.6	2	1	1	1	2	1	2	4	2	6		0	1	1	1	2	1	2
1	0	6	51.3	2	1	1	2	2	1	2	4	1	10		25	1	1	1	1	2	1
1	0	7	80.2	4	1	2	4	2	1	1	4	0	50		0	1	1	2	2	2	0
1	1	8	68.1	3	1	1	3	1	1	1	3	3	4	2	40	1	1	2	2	2	0
1	0	9	61.5	2	1	1	2	1	1	1	4	1	3		25	3	2	2	2	2	0
1	1	10	77.0	4	1	1	1	2	1	1	4	1	8	2	20	1	1	1	1	1	3
1	0	11	47.9	1	1	2	2	1	1	2	3	8	10		0	1	1	2	2	2	0
1	0	12	60.1	2	1	1	4	1	1	2	3	1	40		8	3	2	2	2	2	0
1	1	13	77.9	4	1	2	1	2	1	2	3	9	5	3	10	1	1	1	1	2	1
1	1	14	88.0	5	1	1	3	1	2	2	4	1	30	6	0	1	1	2	2	2	0
1	1	15	90.6	5	1	2	3	2	1	1	2	2	10	10	24	1	1	1	2	1	2
1	1	16	69.9	3	1	1	1	1	2	2	4	8	2	3	9	1	1	1	1	1	3
1	1	17	74.6	3	1	2	1	2	1	2	3	3	5	4	22	1	1	1	1	2	1
1	1	18	77.8	4	1	1	1	1	1	2	4	5	10	8	15	1	1	1	2	1	2
1	0	19	71.1	3	1	2	1	2	1	1	3	1	3		0	3	2	2	2	2	0
1	1	20	71.5	3	1	1	2	2	1	2	4	3	5	4	15	1	1	2	2	2	0
1	1	21	71.7	3	1	1	1	1	1	1	3	1	10	10	0	2	1	1	1	2	1
1	1	22	88.9	5	1	1	2	2	1	2	3	3	7	6	25	1	1	1	1	2	1
1	0	23	32.6	1	1	1	1	1	1	2	3	1	3		15	1	1	2	2	2	0
1	0	24	70.3	3	1	1	1	2	1	2	4	1	10		8	1	1	1	1	2	1
1	1	25	62.1	2	1	2	1	1	1	1	2	0	40	10	0	2	1	2	2	2	0
1	1	26	73.2	3	1	1	1	2	1	2	3	2	7	14	23	3	2	2	2	2	0

Time	matched	ID	Final Mark	Grade	Campus	Sex	Age	FIF	Diploma	Previous Study	Number of Subjects	Field of Study	Study hours pre	Study hours post	Work hours pre	ATAR	Yr12	Science	Biology	Chemistry	HSSci
1	1	27	62.7	2	1	1	2	1	1	2	3	1	4	2	27	2	1	2	2	2	0
1	0	28			1	1	2	1	1	2	4	1	10		0	3	2	2	2	2	0
1	1	29	82.7	4	1	2	4	2	1	2	4	8	9	4	0	2	1	2	2	2	0
1	0	30	49.8	1	1	2	1	1	2	2	3	0	2		5	1	1	1	1	1	3
1	1	31	54.3	2	1	1	1	2	1	2	4	3	10	3	12	1	1	2	2	2	0
1	1	32	70.6	3	1	1	1	2	1	2	4	1	5	6	15	2	1	1	1	2	1
1	1	33	52.0	2	1	1	1	1	1	2	3	1	8	10	5	1	1	1	1	2	1
1	1	34	90.5	5	1	2	1	2	2	1	3	12	1	0	30	1	1	1	1	1	3
1	1	35	45.5	1	1	1	1	2	1	2	3	5	12	6	20	1	1	1	1	1	3
1	1	36	55.7	2	1	1	2	2	1	2	3	1	6	12	0	2	1				
1	1	37	59.0	2	1	1	2	2	1	2	4	1	40	30	0	2	1	1	1	2	1
1	0	38	65.1	3	1	2	1	2	1	2	3	6	5		0	1	1	1	2	1	2
1	0	39	61.5	2	1	1	1	1	1	2	4	1	10		9	1	1	1	1	1	3
1	0	40	62.0	2	1	2	1	2	1	2	3	8	4		4	1	1	1	1	1	3
1	0	41	75.0	4	1	1	4	2	1	1	4	1	6		40	1	1	1	1	1	3
1	1	42	75.3	4	1	1	1	2	1	2	4	5	4	4	8	2	1	1	1	1	3
1	0	43	67.8	3	1	1	3	1	1	2	2	1	6		20	3	2	2	2	2	0
1	0	44	47.3	1	1	2	1	2	1	2	4	6	5		15	1	1	1	1	1	3
1	0	45			1	1	1	2	1	2	4	1	6		0	2	1	2	2	2	0
1	0	46	73.7	3	1	2	1	1	1	2	3	5	5		24	1	1	1	2	1	2
1	0	47	52.8	2	1	1	2	1	1	2	3	0	7		30	3	2	2	2	2	0
1	0	48	77.6	4	1	2	1	2	1	2	3	5	5		24	1	1	1	1	1	3
1	0	49	57.9	2	1	1	4	2	1	2	3	1	12		0	3	2	2	2	2	0
1	0	50	65.3	3	1	2	3	1	2	1	3	8	30		0	3	2	2	2	2	0

Time	matched	ID	Final Mark	Grade	Campus	Sex	Age	FIF	Diploma	Previous Study	Number of Subjects	Field of Study	Study hours pre	Study hours post	Work hours pre	ATAR	Yr12	Science	Biology	Chemistry	HSSci
1	1	51	65.4	3	1	1	2	1	1	1	3	1	10	8	20	1	1	1	1	2	1
1	0	53	82.9	4	1	2	1	2	1	2	4	5	8		0	1	1	1	1	1	3
1	1	54	62.3	2	1	2	2	2	1	2	4	7	5	1	20	1	1	1	1	2	1
1	0	55	76.4	4	1	1	2	1	1	2	3	5	10		25	1	1	1	1	1	3
1	1	56	64.8	2	1	1	1	1	1	2	3	0	10	4	6	1	1	1	1	1	3
1	1	57	62.2	2	1	1	1	1	1	1	4	1	8	6	10	2	1	2	2	2	0
1	0	58	11.8	1	1	2	1	2	1	2	4	6	10		20	2	1	1	1	2	1
1	1	59	55.4	2	1	1	1	1	1	2	4	5	6	5	10	1	1	2	2	2	0
1	1	60	80.0	4	1	2	1	2	1	1	4	5	10	8	0	3	2	2	2	2	0
1	0	61	37.9	1	1	1	2	1	1	2	4	9	10		15	3	2	2	2	2	0
1	1	62	61.0	2	1	1	4	1	1	1	3	1	30	5	0	3	2	2	2	2	0
1	1	63	54.4	2	1	1	2	1	1	2	3	1	4	8	0	2	1	2	2	2	0
1	1	64	9.3	1	1	2	1	2	1	2	3	1	10	8	0	1	1	1	1	2	1
1	1	65	37.0	1	1	1	1	1	1	2	4	1	10	5	70	2	1	1	2	1	2
1	0	66	53.9	2	1	1	1	2	1	2	3	3	4		20	1	1	1	1	2	1
1	1	67	64.2	2	1	2	3	1	1	2	2	3	10	2	40	2	1	2	2	2	0
1	0	68	55.2	2	1	2	2	2	1	2	4	6	5		10	2	1	2	2	2	0
1	0	82	47.5	1	2	1	1	2	1	1	2	1	12		20	2	1	1	1	2	1
1	0	100	76.5	4	2	1	1	1	1	2	1	1	6		10	1	1	1	1	2	1
2	2	14	88.0	5	1	1	3	1	2	2	4	1	30	6	0	1	1	2	2	2	0
2	2	25	62.1	2	1	2	1	1	1	1	2	0	40	10	0	2	1	2	2	2	0
2	2	16	69.9	3	1	1	1	1	2	2	4	8	2	3	9	1	1	1	1	1	3
2	2	2	83.3	4	1	1	2	2	1	2	4	2	50	30	12	1	1	1	1	1	3
2	2	1	72.7	3	1	2	3	2	1	1	4	0	12	6	25	1	1	2	2	2	0

Time	matched	ID	Final Mark	Grade	Campus	Sex	Age	FIF	Diploma	Previous Study	Number of Subjects	Field of Study	Study hours pre	Study hours post	Work hours pre	ATAR	Yr12	Science	Biology	Chemistry	HSSci
2	2	13	77.9	4	1	2	1	2	1	2	3	9	5	3	0	1	1	1	1	2	1
2	2	22	88.9	5	1	1	2	2	1	2	3	3	7	6	24	1	1	1	1	2	1
2	2	54	62.3	2	1	2	2	2	1	2	4	6	5	1	20	1	1	1	1	2	1
2	2	31	54.3	2	1	1	1	2	1	2	4	3	10	3	0	1	1	2	2	2	0
2	2	15	90.6	5	1	2	3	2	1	1	2	2	10	10	30	1	1	1	2	1	2
2	2	26	73.2	3	1	1	1	2	1	2	2	2	7	14	22	3	2	2	2	2	0
2	2	35	45.5	1	1	1	1	2	1	2	3	5	12	6	30	1	1	1	1	1	3
2	2	34	90.5	5	1	2	1	2	2	1	3	12	1	0	5	1	1	1	1	1	3
2	3	76	57.2	2	1	1	1		1		2	13		8	30						
2	2	4	84.5	4	1	1	2	1	1	2	2	7	6	7	30	3	2	2	2	2	0
2	2	8	68.1	3	1	1	3	1	1	1	3	3	4	2	45	1	1	2	2	2	0
2	2	10	77.0	4	1	1	1	2	1	1	4	1	8	2	0	1	1	1	1	1	3
2	2	56	64.8	2	1	1	1	1	1	2	3	1	10	4	3	1	1	1	1	1	3
2	2	32	70.6	3	1	1	1	2	1	2	4	1	5	6	25	2	1	1	1	2	1
2	2	29	82.7	4	1	2	4	2	1	2	4	8	9	4	0	2	1	2	2	2	0
2	2	59	55.4	2	1	1	1	1	1	2	3	5	6	5	20	1	1	2	2	2	0
2	2	67	64.2	2	1	2	3	1	1	2	2	3	10	2	38	2	1	2	2	2	0
2	2	17	74.6	3	1	2	1	2	1	2	3	3	5	4	20	1	1	1	1	2	1
2	2	18	77.8	4	1	1	1	1	1	2	4	5	10	8	20	1	1	1	2	1	2
2	2	36	55.7	2	1	1	2	2	1	2	3	1	6	12	0	2	1				
2	3	72	48.6	1	1	1	1		1		4	1		10	15						
2	2	27	62.7	2	1	1	2	1	1	2	3	1	4	2	28	2	1	2	2	2	0
2	2	21	71.7	3	1	1	1	1	1	1	3	1	10	10	0	2	1	1	1	2	1
2	2	42	75.3	4	1	1	1	2	1	2	4	5	4	4	10	2	1	1	1	1	3

Time	matched	ID	Final Mark	Grade	Campus	Sex	Age	FIF	Diploma	Previous Study	Number of Subjects	Field of Study	Study hours pre	Study hours post	Work hours pre	ATAR	Yr12	Science	Biology	Chemistry	HSSci
2	3	75	48.5	1	1	2	1	2	1	2	3	1		2	5	1	1	1	1	1	3
2	2	65	37.0	1	1	1	1	1	1	2	4	1	10	5	0	2	1	1	2	1	2
2	2	57	62.2	2	1	1	1	1	1	1	4	1	8	6	30	2	1	2	2	2	0
2	2	51	65.4	3	1	1	2	1	1	1	3	1	10	8	22	1	1	1	1	2	1
2	2	62	61.0	2	1	1	4	1	1	1	3	1	30	5	0	3	2	2	2	2	0
2	3	77	83.6	4	1	1	2		1		4	1		4	20						
2	2	64	9.3	1	1	2	1	2	1	2	3	1	10	8	0	1	1	1	1	2	1
2	2	20	71.5	3	1	1	3	2	1	2	4	3	5	4	5	1	1	2	2	2	0
2	2	37	59.0	2	1	1	2	2	1	2	3	1	40	30	0	2	1	1	1	2	1
2	2	33	52.0	2	1	1	1	1	1	2	3	1	8	10	10	1	1	1	1	2	1
2	2	60	80.0	4	1	2	1	2	1	1	4	5	10	8	0	3	2	2	2	2	0
2	2	63	54.4	2	1	1	2	1	1	2	3	1	4	8	0	2	1	2	2	2	0
2	3	71	52.3	2	1	1	1		1		3	1		8	0						
2	2	98	76.3	4	2	1	1	2	1	2	3	1	4	2	0	1	1	2	2	2	0
2	3	85	87.9	5	2	1	2		1		3	2		1	0						
2	3	89	76.7	4	2	2	1		1		2	1		7	0						
2	2	93	90.4	5	2	2	4	2	1	2	2	1	20	15	40	1	1	2	2	2	0
2	2	91	79.9	4	2	1	1	2	1	2	2	3	6		15	1	1	2	2	2	0
2	2	96	82.0	4	2	1	1	2	1	2	4	2	10	8	0	1	1	1	1	2	1
2	3	78	87.6	5	2	2	4	2	1	2	2	11	6		30	2	1	2	2	2	0

Table C-5: MSLQ subscale means for participants from Phase 2

matched	ID	Intrinsic	Extrinsic	Task Value	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognition	Effort Regulation	Environment	Help Seeking
0	80	6.0	7.0	7.0	6.0	4.6	5.8	6.3		5.3	2.0	3.0		5.5		2.5
0	101	5.3	6.0	5.7	5.5	5.1	4.6	5.8		5.3	1.7	4.2		5.8		2.8
0	84	5.3	7.0	7.0	5.0	4.8	3.2	4.5		5.3	1.0	2.8		6.3		1.8
0	97	4.5	6.0	4.7	5.8	4.3	6.0	4.0		5.3	1.7	3.8		5.8		4.3
1	91	4.3	5.3	6.5	6.5	4.4	6.0	4.5		3.3	3.0	2.2		6.0		5.0
0	103	5.3	5.8	6.7	6.0	5.1	4.6	4.3	4.5	5.0	3.3	3.4	4.8	5.5	5.0	4.5
1	98	5.3	6.8	6.8	5.5	5.1	4.4	6.3	6.7	6.5	4.0	4.0	4.9	7.0	6.6	4.8
0	99	5.0	6.8	7.0	5.5	5.0	4.6	6.8	6.3	6.0	4.7	5.2	5.6	6.5	5.0	5.8
1	96	4.5	4.5	6.5	5.5	5.6	2.4	4.5		3.3	2.0	2.4		6.5		1.3
0	94	4.0	6.0	5.0	5.8	4.3	4.8	4.3		2.8	1.0	3.2		6.5		3.0
0	90	4.5	2.8	5.2	3.8	4.0	2.8	5.3	5.7	3.5	3.3	3.6	5.1	5.3	3.9	2.3
0	83	5.5	5.5	6.5	6.3	5.0	5.6	2.5		5.8	3.7	2.4		6.0		5.8
0	87	4.3	6.5	6.5	7.0	7.0	3.2	5.5	7.0	7.0	1.0	5.0	6.0	7.0	7.0	4.8
0	88	3.8	5.0	5.5	5.0	4.0	5.0	3.3		4.0	2.0	3.0		5.3		2.0
1	93	6.5	6.3	7.0	6.8	6.4	3.6	5.8	6.2	5.8	5.3	5.6	4.9	5.3	5.0	5.5
0	102	4.8	5.5	5.2	6.0	4.1	5.4	4.0		4.3	2.3	3.2		3.8		2.8
0	95	5.5	6.3	6.0	5.8	4.9	6.6	4.8		4.5	2.7	4.2		5.0		3.3
0	79	6.0	5.8	6.2	6.3	5.9	5.0	6.0		6.0	6.0	6.0		4.0		5.0
0	104	5.8	5.3	6.5	6.8	6.1	3.8	5.3		6.0	5.0	3.2		6.5		4.5
0	86	4.5	5.3	6.0	6.3	5.5	3.0	6.0		6.8	5.7	3.2		6.3		5.8
1	1	7.0	7.0	7.0	5.8	6.9	7.0	6.3	6.5	6.8	7.0	5.8	5.5	6.8	5.9	4.8
1	2	5.8	7.0	6.8	6.3	6.1	5.6	6.3		6.3	3.0	5.2		6.0		4.5
0	3	5.3	4.3	6.2	4.5	4.3	6.0	4.8		5.0	5.0	4.8		4.5		4.8
1	4	5.0	6.0	5.2	5.5	4.5	6.0	3.0		3.3	3.7	1.6		4.5		4.0
0	5	4.5	6.0	6.5	5.5	5.1	5.0	3.0		4.3	3.0	2.6		5.8		2.5
0	6	5.5	6.3	6.5	4.5	4.9	4.4	5.5		5.5	6.0	2.4		6.0		6.0
0	7	5.5	4.0	6.2	6.3	6.4	2.4	4.0		5.0	1.7	6.0		6.5		3.0
1	8	6.8	5.8	7.0	6.3	6.5	2.8	5.3		6.5	3.3	6.4		6.8		4.3
0	9	4.8	4.3	6.8	4.0	5.9	4.4	3.5		4.0	4.3	2.2		6.8		5.3
1	10	4.3	5.0	6.0	6.0	3.8	6.2	5.3		5.5	4.3	4.4		4.0		5.8
0	11	6.0	5.5	7.0	6.3	6.6	1.0	7.0		4.0	6.0	5.2		6.8		4.0
0	12	6.8	5.3	6.8	5.0	3.1	7.0	5.3		6.0	2.3	3.0		6.8		3.0
1	13	4.5	6.0	5.5	5.8	4.1	5.8	2.5	3.0	2.8	2.0	3.6	3.9	4.5	5.1	2.0
1	14	6.3	3.8	7.0	6.5	5.5	4.2	6.5	5.8	6.8	4.7	3.4	6.0	5.5	7.0	5.8
1	15	6.3	7.0	7.0	6.5	6.8	4.2	6.8		7.0	6.3	5.2		6.5		6.3
1	16	6.3	5.5	5.3	6.5	5.9	7.0	6.5	5.6	7.0	2.7	4.4	4.7	6.5	5.6	1.5
1	17	5.0	5.3	6.0	6.0	5.9	3.0	4.8	4.7	4.5	4.7	4.8	4.8	5.0	4.3	3.5
1	18	4.3	4.8	6.7	5.5	3.4	3.0	4.8	2.2	3.8	2.0	1.8	3.0	5.8	6.1	3.3
0	19	5.5	5.8	5.5	6.0	6.1	1.8	2.3		3.3	3.0	3.6		5.8		5.8

matched	ID	Intrinsic	Extrinsic	Task Value	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognition	Effort Regulation	Environment	Help Seeking
1	20	5.5	5.3	5.8	6.5	5.4	5.4	6.5		5.8	4.3	3.4		6.0		4.0
1	21	3.5	3.3	4.8	4.5	3.6	3.4	2.5	3.7	3.8	4.0	3.2	4.1	4.8	4.5	3.5
1	22	6.5	6.5	7.0	6.0	5.3	5.0	6.5	5.3	6.8	4.7	4.8	5.9	5.3	6.5	6.3
0	23	4.3	4.5	4.7	4.8	2.1	3.0	3.3		3.3	1.3	2.4		3.8		1.5
0	24	5.5	7.0	7.0	7.0	5.6	7.0	7.0		6.5	4.7	3.8		7.0		4.5
1	25	2.8	2.8	2.5	2.8	2.4	2.6	2.5		2.0	2.7	2.6		4.5		3.5
1	26	5.5	5.8	6.8	5.3	4.9	6.6	6.0	6.0	4.8	2.3	3.2	5.0	5.0	4.6	2.3
1	27	4.3	5.0	5.8	7.0	4.0	7.0	4.0		4.0	4.0	1.4		2.0		3.8
0	28	6.5	5.0	6.5	4.8	5.0	5.8	5.3	5.6	5.0	4.3	4.6	5.4	4.8	5.1	4.0
1	29	6.5	4.0	6.7	6.8	6.1	1.6	4.3	5.8	4.5	2.3	5.4	5.1	6.0	4.9	2.3
0	30	4.5	6.0	5.2	7.0	6.3	5.0	2.8		4.3	1.3	1.2		6.3		1.8
1	31	4.0	3.3	5.2	5.3	4.4	5.8	2.5		3.8	1.3	2.6		2.8		1.8
1	32	5.0	5.3	6.0	5.5	4.4	5.0	4.3		5.0	4.7	4.2		4.8		3.5
1	33	3.5	5.5	4.8	3.5	3.6	4.4	3.0		3.5	3.0	3.4		6.0		3.8
1	34	3.0	2.5	3.8	5.8	5.0	7.0	4.3		4.0	2.0	4.6		2.3		1.0
1	35	5.5	6.0	6.7	6.8	5.1	4.2	7.0		7.0	4.3	4.2		6.8		3.0
1	36	5.3	5.3	5.7	5.8	4.9	3.4	6.0		5.8	6.0	5.4		6.0		5.5
1	37	5.5	5.5	6.5	5.8	4.5	6.6	5.8		4.5	6.0	3.6		5.8		4.5
0	38	5.0	4.5	5.8	5.5	4.6	4.2	4.8	5.2	4.3	4.3	4.2	5.1	5.5	5.8	5.0
0	39	5.3	6.5	6.7	5.8	5.3	5.8	3.8		5.3	1.7	3.4		5.5		4.5
0	40	4.8	5.0	4.7	5.5	5.8	5.8	4.8		4.5	4.7	4.6		3.3		3.8
0	41	4.3	7.0	6.3	5.8	3.4	7.0	5.3	5.2	5.5	3.3	4.8	4.9	6.0	4.9	3.0
1	42	3.8	4.8	4.7	4.8	4.5	4.6	4.5		5.0	3.3	3.4		5.0		2.5
0	43	4.3	6.5	6.0	6.8	4.9	6.4	7.0		4.8	2.0	3.6		6.3		4.5
0	44	4.5	5.5	5.8	5.3	4.6	4.8	4.8		4.3	4.3	4.6		5.3		4.0
0	45	6.8	6.3	6.7	6.5	4.9	3.4	4.8		4.3	4.0	3.4		5.8		4.0
0	46	4.8	4.3	4.5	5.0	4.3	5.4	4.8		3.8	3.7	3.2		3.3		4.8
0	47	6.3	7.0	6.3	6.0	4.3	7.0	6.5		5.8	4.7	5.0		6.0		5.0
0	48	4.8	5.0	5.0	5.0	5.4	3.2	4.8		4.3	4.3	4.2		4.5		4.3
0	49	6.0	5.8	6.7	7.0	5.5	5.8	5.3		6.5	2.0	3.4		4.3		2.8
0	50	6.3	4.5	6.0	5.5	5.6	3.0	4.8		4.3	4.3	4.6		5.3		2.5
1	51	4.8	5.0	6.2	4.8	4.9	4.6	5.0	4.8	4.3	5.0	3.8	4.6	5.5	4.6	4.5
0	53	5.3	7.0	5.7	5.3	5.4	5.0	4.0		5.0	6.0	5.2		4.0		4.8
1	54	5.3	4.8	5.5	5.8	5.0	3.8	5.5	4.5	4.3	3.3	4.0	4.7	5.0	5.8	4.8
0	55	5.5	5.3	5.7	5.8	4.9	5.2	5.0		4.8	3.7	3.8		3.8		4.8
1	56	4.5	5.3	6.2	6.8	4.6	4.6	4.0	4.2	4.3	4.3	3.0	4.3	4.3	4.8	3.5
1	57	3.5	4.3	5.3	5.0	4.0	4.0	6.3		4.5	5.3	4.0		5.5		5.8
0	58	4.5	6.3	5.5	6.5	4.3	5.8	3.5	3.8	4.3	4.3	4.4	3.3	4.0	4.0	2.8
1	59	5.0	5.0	5.8	6.8	4.8	5.8	5.5		5.5	1.7	3.2		6.8		4.3
1	60	4.8	6.5	5.8	6.5	5.8	2.2	4.5	5.0	5.0	1.0	2.6	5.9	6.8	5.8	1.0

matched	ID	Intrinsic	Extrinsic	Task Value	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognition	Effort Regulation	Environment	Help Seeking
0	61	6.3	7.0	7.0	6.8	4.3	4.8	5.0		5.8	2.0	3.8		6.0		2.5
1	62	5.3	6.0	6.8	6.0	2.9	4.8	5.8	4.5	5.5	1.3	4.2	4.7	5.5	6.5	5.0
1	63	6.0	7.0	6.2	5.8	5.8	5.4	4.8		4.8	5.3	5.0		6.3		4.5
1	64	4.5	3.8	5.3	4.8	3.5	2.8	4.5		5.0	5.0	4.0		6.5		5.5
1	65	5.8	6.0	6.8	6.0	4.3	5.8	3.5		5.8	4.3	3.4		4.0		4.0
0	66	4.8	5.0	5.2	5.0	5.0	5.0	5.5		5.0	5.3	5.6		3.8		5.0
1	67	6.0	4.5	6.0	5.5	5.0	2.8	4.5	5.2	4.0	2.7	5.0	5.1	6.0	4.0	2.8
0	68	5.0	5.3	5.2	5.3	5.0	3.4	4.5		4.8	4.7	4.6		3.5		4.0
0	82	5.0	6.8	6.8	5.8	6.0	5.0	5.5	5.2	5.8	5.0	5.2	5.2	5.5	4.6	4.5
0	100	4.8	5.3	5.5	4.8	4.1	4.8	4.3	4.5	4.0	4.7	3.6	4.3	4.0	5.0	4.5
2	14	6.8	4.5	7.0	6.3	6.6	3.6	4.8	6.7	7.0	5.0	6.0	6.3	5.5	7.0	4.8
2	25	2.3	2.3	2.2	3.0	2.4	2.0	1.5	2.3	2.0	2.3	1.8	2.3	4.5	3.6	3.8
2	16	4.8	4.5	4.7	6.3	3.9	7.0	6.0	5.7	5.8	2.3	5.8	5.4	6.0	5.1	1.3
2	2	5.0	7.0	7.0	6.8	5.9	7.0	5.3	5.3	5.3	1.7	4.6	5.3	2.0	5.5	2.8
2	1	6.5	7.0	6.7	7.0	6.3	6.8	6.0	6.3	4.0	5.0	5.4	4.9	4.5	4.8	4.0
2	13	5.3	5.8	5.3	6.3	5.5	6.4	3.5	5.5	4.0	1.7	4.8	3.3	4.8	4.5	1.3
2	22	7.0	7.0	7.0	7.0	6.3	6.4	5.5	6.7	7.0	6.3	5.6	6.3	6.8	6.6	5.3
2	54	4.8	4.0	4.0	4.8	4.1	3.4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2	31	5.0	5.3	5.7	5.3	4.5	5.0	4.3	4.0	5.0	3.7	4.0	3.8	3.5	4.4	3.8
2	15	5.8	6.5	7.0	7.0	7.0	3.4	6.8	6.7	6.8	5.7	6.6	6.6	5.8	6.1	6.0
2	26	6.5	5.8	7.0	6.5	6.8	5.4	5.5	6.8	6.5	4.3	6.0	6.1	6.3	4.9	4.5
2	35	5.8	4.8	7.0	6.8	5.0	4.4	6.8	6.3	6.0	5.7	5.2	5.3	5.8	6.0	3.8
2	34	3.5	3.3	4.3	5.8	6.0	7.0	3.3	3.7	2.5	3.0	3.8	2.9	2.3	3.5	1.5
3	76	3.5	4.5	3.7	4.3	3.4	3.6	3.3	2.5	3.5	3.7	3.2	3.8	3.8	3.8	3.5
2	4	5.3	6.8	7.0	6.5	5.9	6.2	3.8	4.2	4.0	5.0	3.4	3.9	5.5	4.3	5.3
2	8	7.0	5.5	7.0	6.5	5.8	4.4	5.0	6.8	5.3	2.3	6.4	6.5	6.8	5.0	5.8
2	10	5.0	5.0	6.5	6.3	4.3	5.6	4.5	5.5	5.5	5.7	5.0	4.9	4.0	3.8	6.5
2	56	4.3	5.8	6.5	5.3	4.8	5.8	3.8	4.2	4.8	3.7	3.8	3.9	4.3	4.9	2.5
2	32	5.3	5.5	6.5	6.3	5.3	4.8	5.0	5.0	5.3	5.0	5.0	4.4	5.8	4.6	4.5
2	29	5.5	1.0	5.7	5.5	5.4	1.0	4.0	5.3	4.0	2.3	4.0	5.1	6.3	4.8	2.3
2	59	5.0	6.3	6.8	7.0	5.6	6.2	6.5	5.5	6.3	3.7	5.2	6.0	6.8	5.6	2.5
2	67	4.8	4.0	5.3	5.8	4.3	3.4	4.3	4.0	3.5	3.3	4.2	4.7	5.3	4.0	3.5
2	17	5.5	4.8	5.3	5.5	5.0	2.2	3.8	5.0	4.3	4.3	4.2	4.3	4.8	4.1	3.0
2	18	5.0	5.5	6.7	5.0	5.3	5.0	5.5	4.7	4.5	2.7	3.8	3.7	5.8	6.0	3.8
2	36	6.5	6.0	6.7	6.8	6.0	3.0	6.5	6.0	6.3	6.0	6.2	6.3	6.8	6.1	4.5
3	72	3.8	5.0	4.8	4.8	4.0	4.0	4.8	4.0	4.3	4.0	4.0	4.7	4.3	4.8	4.3
2	27	4.0	2.5	5.5	6.8	2.9	5.2	2.3	3.2	1.8	4.0	1.8	1.5	2.0	1.8	5.3
2	21	5.5	5.0	6.0	5.8	5.3	4.6	4.5	4.7	5.3	4.3	5.4	4.6	4.3	5.4	4.3
2	42	3.5	3.8	5.5	5.3	4.6	5.0	3.8	4.3	4.5	2.3	3.6	4.4	5.0	5.0	3.5
3	75	6.8	7.0	6.8	5.8	5.3	3.8	6.3	6.8	6.0	3.7	6.6	5.8	5.5	5.9	4.3

matched	ID	Intrinsic	Extrinsic	Task Value	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognition	Effort Regulation	Environment	Help Seeking
2	65	4.0	5.8	6.0	5.8	3.6	7.0	4.0	3.3	3.0	5.3	3.4	3.7	4.5	3.5	2.5
2	57	3.0	2.8	3.0	3.3	2.5	3.4	5.5	4.5	3.8	1.3	4.8	4.6	6.0	5.9	6.0
2	51	5.3	4.5	6.3	5.0	4.1	5.2	5.5	5.0	3.8	4.0	2.6	3.3	4.5	3.5	4.5
2	62	4.0	6.3	6.5	6.8	1.1	3.2	6.0	3.0	4.5	1.0	2.4	3.6	7.0	5.3	5.5
3	77	5.5	5.0	6.3	5.3	4.4	4.4	5.8	5.5	6.0	6.0	4.4	5.3	4.8	4.9	4.8
2	64	5.3	4.5	6.0	6.8	5.1	3.6	5.8	5.7	6.0	5.0	4.6	5.1	6.0	4.5	4.5
2	20	3.8	4.8	4.2	5.3	4.1	3.8	4.3	4.8	4.5	4.7	4.4	3.9	5.0	5.3	3.0
2	37	4.5	4.0	6.2	5.5	3.6	6.0	4.3	3.7	3.8	5.0	3.8	3.8	4.3	4.3	5.0
2	33	3.5	5.0	4.7	3.5	3.0	4.6	3.0	2.7	3.3	3.0	3.2	3.6	3.8	4.1	3.0
2	60	6.0	4.3	6.0	6.8	6.8	1.0	1.5	5.7	3.3	1.7	3.0	4.8	6.5	6.0	1.0
2	63	6.8	7.0	6.3	6.5	4.9	6.4	6.3	4.7	4.8	3.3	5.8	5.1	5.0	6.5	5.5
3	71	6.0	6.5	6.8	6.3	5.1	5.6	6.0	6.2	6.8	4.3	5.4	5.5	5.3	4.6	5.5
2	98	5.3	5.0	5.7	5.5	4.6	3.8	5.3	5.7	5.0	4.0	3.4	4.6	6.0	5.9	4.8
3	85	5.8	6.8	7.0	7.0	6.0	5.4	3.0	3.8	3.8	2.0	3.0	2.5	2.8	2.9	1.8
3	89	3.8	7.0	6.2	5.5	4.5	3.6	4.0	4.0	5.3	4.0	2.0	5.2	6.8	5.8	6.5
2	93	6.0	6.5	7.0	7.0	6.0	4.6	5.5	6.2	5.8	5.0	5.8	5.3	4.8	5.5	5.8
2	91	5.5	5.5	6.5	6.5	4.3	6.0	6.3	4.8	5.8	2.7	1.4	4.4	6.0	5.9	3.8
2	96	4.0	4.3	6.7	6.8	5.6	2.0	4.5	4.8	3.8	2.7	2.0	4.4	6.3	6.8	3.5
3	78	6.5	7.0	7.0	7.0	7.0	2.8	4.0	6.2	5.0	3.3	5.8	5.5	5.3	5.4	2.8

Table C-6: Demographic data of participants from Phase 3

Timestamp	ID	Subject	BM1111	Age	Number of Subjects	Field of Study	Study Hours	Work Hours	COVID
21-Apr-20	1	7	2	1	4	5	5	9	1
21-Apr-20	2	7	2	2	4	5	4	20	2
21-Apr-20	3	6	2	1	4	10	5	13	1
22-Apr-20	4	6	2	1	4	2	2	8	1
22-Apr-20	5	6	2	1	4	10	4	0	1
22-Apr-20	6	6	2	1	4	2	5	0	1
22-Apr-20	7	6	2	1	4	10	5	0	1
22-Apr-20	8	1	1	3	4	1	12	0	2
22-Apr-20	9	6	2	1	4	10	5	0	1
24-Apr-20	10	6	2	1	4	2	4	0	1
27-Apr-20	11	2	2	1	4	3	4	10	1
27-Apr-20	12	2	2	2	4	3	10	35	1
27-Apr-20	13	2	2	1	4	3	5	6	1
28-Apr-20	14	6	2	1	4	9	5	15	2
29-Apr-20	15	1	2	1	4	10	8	15	1
29-Apr-20	16	1	2	2	3	1	10	5	1
29-Apr-20	17	1	2	1	3	1	27	126	2
29-Apr-20	18	1	1	1	4	1	9	6	1
29-Apr-20	19	1	1	1	2	1	20	16	1
29-Apr-20	20	1	2	1	4	1	8	24	1
30-Apr-20	21	5	2	2	4	1	3	15	1
30-Apr-20	22	5	2	3	2	6	15	25	1
1-May-20	23	6	2	1	4	2	3	0	1
1-May-20	24	6	2	1	4	2	1	20	1
1-May-20	25	1	2	3	4	11	8	0	2
2-May-20	26	2	2	2	4	3	8	0	1
2-May-20	27	3	2	1	4	7	4	0	1
4-May-20	28	1	2	1	4	1	9	30	1
5-May-20	29	1	2	2	4	1	30	8	2
6-May-20	30	1	2	3	4	1	5	3	2
7-May-20	31	2	1	3	4	3	6	15	1
8-May-20	32	5	2	1	4	6	5	5	1
11-May-20	33	3	2	1	4	7	6	0	1
12-May-20	34	2	1	1	4	3	6	13	1
12-May-20	35	3	2	1	4	7	5	0	1
12-May-20	36	3	1	3	4	7	12	15	1
12-May-20	37	7	2	1	4	5	2	10	1
12-May-20	38	2	2	1	4	3	3	0	1
12-May-20	39	5	2	6	1	4	50	0	1

Timestamp	ID	Subject	BM1111	Age	Number of Subjects	Field of Study	Study Hours	Work Hours	COVID
13-May-20	40	5	1	2	4	7	2	16	1
13-May-20	41	3	2	3	4	7	4	18	1
13-May-20	42	1	2	1	4	1	6	45	1
13-May-20	43	1	2	1	4	1	4	0	1
13-May-20	44	6	2	1	4	10	4	20	1
13-May-20	45	6	2	1	4	13	2	9	1
13-May-20	46	2	2	4	4	3	18	0	1
13-May-20	47	6	2	1	4	10	2	0	2
13-May-20	48	1	2	1	4	1	10	13	2
13-May-20	49	6	2	1	4	13	4	5	1
13-May-20	50	1	2	2	4	1	5	9	1
14-May-20	51	2	2	1	4	3	4	10	1
14-May-20	52	1	2	1	4	1	5	0	1
14-May-20	53	6	2	2	2	2	15	0	2
14-May-20	54	1	2	1	4	1	2	6	1

Table C-7 MSLQ subscale means for participants from Phase 3

ID	Intrinsic	Extrinsic	TV	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognition	Effort	Environment	Help
1	4.3	5.8	6.2	6.5	4.5	3.6	5.8	4.3	4.3	5.7	2.4	5.6	7.0	5.6	5.8
2	4.5	5.8	6.7	6.5	5.1	5.2	3.5	4.7	4.0	2.7	4.0	4.8	4.8	4.1	2.0
3	5.3	7.0	7.0	5.8	4.5	4.2	3.0	6.3	6.3	3.7	2.0	4.8	6.3	6.0	3.8
4	6.0	6.5	7.0	7.0	5.6	6.4	5.5	5.8	4.3	4.7	5.4	5.8	5.5	5.1	4.5
5	6.0	6.8	7.0	6.5	6.1	5.8	5.0	6.0	6.3	4.0	3.0	3.8	6.0	5.8	4.0
6	5.8	6.3	6.3	6.3	4.1	7.0	7.0	6.7	6.5	4.3	4.6	3.4	6.3	5.8	4.5
7	5.0	6.3	6.8	6.3	5.6	5.6	5.3	5.2	4.0	5.0	3.2	4.9	5.8	5.6	5.3
8	6.5	3.5	7.0	6.5	6.5	1.8	3.5	6.8	6.5	3.3	5.6	6.8	5.5	7.0	4.5
9	3.8	6.3	6.7	6.3	6.6	3.2	5.5	5.8	4.8	3.3	2.6	4.9	6.3	6.0	4.5
10	2.5	5.8	5.8	5.3	4.4	7.0	6.8	5.5	5.3	1.7	3.4	5.5	5.0	5.3	3.8
11	5.0	5.3	6.2	6.0	3.9	6.6	6.3	5.3	6.3	6.0	4.2	5.2	5.0	3.6	1.5
12	4.5	6.8	6.7	6.8	4.4	6.8	6.5	4.3	5.8	7.0	2.8	5.3	5.3	6.4	6.3
13	4.5	4.5	5.3	6.0	4.4	5.2	3.8	4.0	4.3	3.3	4.2	3.7	4.5	4.6	3.5
14	4.0	5.0	5.7	4.5	4.3	3.0	4.3	5.2	4.8	4.3	3.6	4.1	5.0	5.1	4.8
15	6.8	5.8	6.8	6.8	6.9	2.0	4.0	6.5	4.8	4.3	3.6	5.8	5.5	5.8	2.0
16	4.3	4.5	5.3	6.0	3.6	6.2	5.3	7.0	6.5	7.0	3.4	5.3	6.3	4.9	5.8
17	3.8	5.5	5.3	6.5	3.1	5.4	5.0	3.7	4.3	4.0	3.2	3.8	3.5	3.8	3.8
18	4.3	5.8	6.5	6.0	3.9	7.0	3.5	4.0	4.0	3.7	3.8	3.8	3.8	4.1	3.8
19	4.3	5.8	7.0	6.3	3.8	6.4	5.0	5.7	6.8	5.3	3.4	4.6	3.8	5.4	3.3
20	4.3	5.8	5.5	4.0	3.4	6.8	4.8	5.0	4.5	5.7	3.8	4.6	4.5	3.4	4.3
21	4.8	3.0	5.2	4.8	3.5	4.2	5.3	5.2	3.5	2.0	3.6	4.1	2.8	3.6	1.8
22	5.0	4.5	5.8	5.5	4.3	2.2	4.0	5.8	5.5	5.0	3.4	4.9	6.8	5.5	4.0
23	3.0	4.8	5.2	5.8	2.4	4.8	2.5	2.7	2.3	2.0	1.8	2.3	2.3	2.0	3.3
24	3.8	7.0	6.3	6.5	3.5	7.0	5.8	5.0	3.0	3.3	4.4	4.8	3.3	4.1	5.3
25	6.3	6.0	7.0	6.5	7.0	1.2	6.0	6.3	6.5	6.0	5.4	5.7	5.5	6.6	4.0
26	6.0	6.8	6.7	6.0	5.8	5.4	6.8	6.3	6.5	3.7	4.4	6.2	7.0	6.1	5.3
27	5.8	5.5	7.0	5.3	4.6	5.4	4.3	6.7	6.3	3.3	3.6	5.5	6.5	6.3	6.3
28	5.3	5.8	6.8	5.0	3.4	6.6	4.5	5.0	5.3	4.7	4.6	4.2	4.8	4.1	2.8
29	3.8	4.8	6.0	4.8	1.6	3.6	2.0	6.2	4.0	3.3	2.4	3.3	5.8	5.3	1.8
30	5.0	6.0	6.2	6.3	4.6	4.4	5.3	3.7	6.3	4.0	3.4	5.2	6.0	6.0	2.8
31	6.5	6.5	6.5	5.5	5.0	6.8	5.5	5.8	7.0	6.3	5.4	5.4	5.5	7.0	6.0
32	5.8	5.5	6.5	5.8	5.0	2.4	3.8	6.5	6.5	5.0	1.6	5.3	6.5	5.8	4.3
33	5.3	5.3	6.0	6.0	5.9	2.8	4.0	5.5	5.8	3.3	5.2	5.6	5.0	5.6	5.0
34	5.3	5.0	6.3	6.8	4.0	6.6	6.0	5.3	6.3	4.0	2.2	4.7	6.0	6.1	4.3
35	4.8	5.5	6.8	6.3	4.3	6.0	6.0	6.5	5.0	2.7	2.6	4.9	4.8	5.9	2.5
36	6.3	6.5	6.8	6.5	5.8	6.6	5.3	5.7	5.5	5.7	3.0	4.4	5.0	5.5	4.5
37	5.0	6.3	6.7	6.5	4.3	5.2	3.3	5.3	4.5	6.0	3.4	4.8	2.5	3.0	6.0
38	3.8	6.0	4.0	3.8	3.0	4.6	4.3	4.3	5.5	6.7	4.4	4.3	4.0	4.4	5.0
39	7.0	3.3	7.0	7.0	2.9	7.0	5.3	4.8	6.5	3.7	2.2	5.2	7.0	6.1	2.3

ID	Intrinsic	Extrinsic	TV	Control	Self-Efficacy	Test Anxiety	Rehearsal	Elaboration	Organisation	Peer Learning	Critical Thinking	Metacognitio n	Effort	Environment	Help
40	1.5	4.8	5.5	2.5	1.3	7.0	1.5	2.0	1.3	3.0	2.6	2.1	3.5	3.3	4.8
41	5.0	5.0	6.3	5.0	5.6	2.8	4.8	4.7	5.0	4.3	3.8	5.6	6.3	6.4	4.5
42	5.5	4.3	6.5	5.5	5.1	6.0	3.5	2.8	3.3	2.7	1.0	2.7	3.5	2.6	2.5
43	5.3	4.5	6.3	6.3	4.5	5.4	5.8	3.8	3.8	4.3	3.2	4.0	4.5	5.6	4.3
44	6.0	6.0	6.3	6.3	5.1	4.8	4.5	5.3	5.5	3.3	3.8	5.4	6.0	5.4	2.0
45	3.8	7.0	5.2	3.0	4.0	5.4	3.5	4.8	3.8	5.3	1.6	4.3	6.3	5.3	4.5
46	5.8	5.0	6.0	5.3	4.4	4.6	5.0	4.8	4.3	2.7	2.6	3.4	5.5	6.6	2.5
47	3.3	5.3	6.0	5.5	3.1	3.6	4.0	5.8	4.5	4.3	2.6	3.6	4.3	4.6	3.5
48	3.8	4.5	6.2	5.3	4.8	3.4	5.5	3.8	3.0	1.7	2.8	4.1	6.8	6.0	3.5
49	6.0	6.5	6.0	5.0	4.4	6.0	6.0	6.0	6.0	5.3	3.8	4.8	5.3	3.4	4.0
50	6.0	5.5	7.0	7.0	6.5	2.8	4.0	4.7	3.8	5.3	3.8	5.6	6.5	6.3	5.3
51	3.3	5.3	4.0	2.8	1.8	6.6	4.5	4.3	3.8	2.3	2.8	2.8	5.3	6.0	3.0
52	5.5	7.0	6.8	5.3	6.1	2.8	3.3	2.7	2.3	3.7	2.8	4.4	4.8	4.8	3.5
53	7.0	4.8	7.0	6.3	5.1	4.0	7.0	4.8	5.5	2.0	5.0	4.2	7.0	7.0	3.3
54	3.5	5.8	6.2	4.8	4.0	7.0	5.3	3.8	4.3	5.7	4.4	3.3	5.0	3.4	5.3

Appendix D – Internal Consistency of MSLQ Subscales

Cronbach's alpha is a measure of internal consistency of a scale. It measures how individual students answer across the items within a scale to determine if they are answering consistently. These Cronbach's alpha values were calculated across each cohort, therefore pre- and post-measurements are all included.

Table D-1: Originally Reported Internal Consistencies

Sub-scale	Cronbach's	Number of items
Intrinsic	0.74	4
Extrinsic	0.62	4
Task Value	0.90	6
Control of learning beliefs	0.68	4
Self-efficacy for learning	0.93	8
Test anxiety	0.80	5
Rehearsal	0.69	4
Elaboration	0.76	6
Organisation	0.64	4
Critical Thinking	0.80	5
Peer Learning	0.76	3
Metacognitive	0.79	12
Effort Regulation	0.69	4
Time & Environment	0.76	8
Help Seeking	0.52	4

Note. Adapted from "A manual for the use of the motivated strategies for learning questionnaire (MSLQ)" by P. Pintrich, D. Smith, T. Garcia, W.J McKeachie, 1991, National Center for Research to Improve Postsecondary Teaching and Learning. (https://files.eric.ed.gov/fulltext/ED338122.pdf).

Table D-2: Internal consistencies from Phase 1 – First Year Students

Sub-scale	Cronbach's	Number of items	Mean inter-item correlation
Intrinsic	0.679	4	0.347
Extrinsic	0.765	4	0.445
Task Value	0.887	6	0.573
Control of learning beliefs	0.751	4	0.464
Self-efficacy of learning	0.929	8	0.622
Test anxiety	0.860	5	0.549
Rehearsal	0.756	4	0.436
Elaboration	0.857	6	0.517
Organisation	0.764	4	0.469
Critical Thinking	0.782	5	0.421
Peer Learning	0.648	3	0.379
Metacognitive	0.814	12	0.276
Effort Regulation	0.695	4	0.369
Time & Environment	0.780	8	0.308
Help Seeking	0.572	4	0.236

Table D-3: Internal Consistencies from Phase 2 – Diploma Students

Sub-scale	Cronbach's	Number of items	Mean inter-item correlation
Intrinsic	0.696	4	0.366
Extrinsic	0.720	4	0.400
Task Value	0.889	6	0.578
Control of learning beliefs	0.659	4	0.362
Self-efficacy for learning	0.919	8	0.590
Test anxiety	0.824	5	0.480
Rehearsal	0.746	4	0.436
Elaboration	0.808	6	0.420
Organisation	0.687	4	0.375
Critical Thinking	0.772	5	0.408
Peer Learning	0.704	3	0.443
Metacognitive	0.811	12	0.277
Effort Regulation	0.734	4	0.409
Time & Environment	0.780	8	0.302
Help Seeking	0.642	4	0.291

Table D-4: Internal Consistencies from Phase 3 – First year students during COVID

Sub-scale	Cronbach's	Number of items	Mean inter-item correlation
Intrinsic	0.798	4	0.502
Extrinsic	0.448*	4	0.172
Task Value	0.815	6	0.415
Control of learning beliefs	0.690	4	0.405
Self-efficacy of learning	0.935	8	0.643
Test anxiety	0.885	5	0.611
Rehearsal	0.640	4	0.309
Elaboration	0.799	6	0.410
Organisation	0.740	4	0.432
Critical Thinking	0.614	5	0.257
Peer Learning	0.586	3	0.325
Metacognitive	0.803	12	0.260
Effort Regulation	0.706	4	0.378
Time & Environment	0.849	8	0.425
Help Seeking	0.574	4	0.245

Appendix E – Spearman's Correlation Matrices for the MSLQ in each Phase

Table E-1: Spearman's rank correlation matrix. Correlation between final mark and subscales of the post-semester MSLQ in Phase 1

		Final Mark	Motivation subscales						Learning strategy subscales									
			IN	EX	SE	CL	TV	TA	RH	EL	OR	CT	PL	MR	ER	TE	HS
Motivation subscales	Intrinsic (IN)	.497**	--														
	Extrinsic (EX)	0.294	.398**	--													
	Self-efficacy for learning (SE)	**.683****	**.662****	0.301	--												
	Control of learning beliefs (CL)	.426**	.481**	.467**	.402**	--											
	Task Value (TV)	.411**	**.608****	.365*	.511**	.768**	--										
	Test Anxiety (TA)	-0.257	0.136	.323*	-0.163	-0.005	-0.012	--									
Learning strategy subscales	Rehearsal (RH)	.417**	**.510****	.375*	**.617****	.468**	**.571****	0.050	--								
	Elaboration (EL)	**.551****	**.558****	.387*	**.661****	**.522****	**.578****	0.021	**.827****	--							
	Organisation (OR)	.438**	**.570****	.321*	**.653****	.372*	.452**	0.019	**.721****	**.794****	--						
	Critical Thinking (CT)	.398**	**.602****	0.247	**.599****	0.259	.366*	0.121	.494**	**.642****	**.564****	--					
	Peer Learning (PL)	0.168	.344*	0.172	.371*	0.207	.307*	0.159	.489**	**.549****	**.516****	.442**	--				
	Metacognitive Regulation (MR)	**.547****	**.685****	.440**	**.787****	.454**	**.543****	-0.020	**.799****	**.826****	**.812****	**.696****	.399**	--			
	Effort Regulation (ER)	.355*	.357*	0.017	**.563****	0.191	.425**	-0.237	.555**	.508**	.430**	0.276	0.181	.573**	--		
	Time & Environment (TE)	**.518****	**.542****	.371*	**.644****	.415**	**.550****	-0.139	**.670****	**.659****	**.635****	**.514****	0.290	.813**	.701**	--	
	Help Seeking (HS)	0.242	0.280	0.218	.370*	.345*	0.234	0.048	.386*	.496**	**.529****	0.186	.563**	.471**	.375*	.347*	--

Note. *Correlation is significant at the 0.01 level (2-tailed). **Correlation is significant at the 0.001 level (2-tailed). Listwise n=42 (all post-semester participants.

Table E-2: Spearman's rank correlation matrix. Correlation between final mark and subscales of the post-semester MSLQ in Phase 2

		Final	Motivation subscales						Learning strategy subscales								
		Mark	IN	EX	SE	CL	TV	TA	RH	EL	OR	CT	PL	MR	ER	TE	HS
Motivation subscales	Intrinsic (IN)	0.250	--														
	Extrinsic (EX)	0.121	**.509****	--													
	Self-efficacy for learning (SE)	**.582****	**.706****	.449**	--												
	Control of learning beliefs (CL)	.313*	**.592****	**.508****	**.653****	--											
	Task Value (TV)	.332*	**.704****	**.672****	**.687****	**.709****	--										
	Test Anxiety (TA)	0.023	0.034	.349*	0.044	0.168	0.186	--									
Learning strategy subscales	Rehearsal (RH)	-0.170	.459**	.392**	0.164	.363*	.465**	0.121	--								
	Elaboration (EL)	0.254	**.797****	.356*	**.668****	**.515****	**.609****	-0.014	.590**	--							
	Organisation (OR)	0.095	**.593****	.483**	.419**	.391**	**.601****	0.084	.720**	**.739****	--						
	Critical Thinking (CT)	0.023	**.644****	.378**	**.511****	.359*	.433**	0.089	**.565****	**.760****	**.688****	--					
	Peer Learning (PL)	-0.040	.313*	0.192	0.153	0.162	.291*	0.100	.307*	.318*	.440**	.356*	--				
	Metacognitive Regulation (MR)	0.119	**.642****	.375**	**.528****	.445**	**.550****	-0.111	**.630****	**.818****	**.802****	**.775****	.331*	--			
	Effort Regulation (ER)	0.067	.333*	0.155	0.275	.332*	.316*	-.323*	.483**	.493**	.452**	0.230	-0.026	.547**	--		
	Time & Environment (TE)	0.213	.415**	.318*	.415**	.337*	.437**	-0.197	**.572****	**.552****	**.577****	.402**	0.020	.630**	.646**	--	
	Help Seeking (HS)	-0.037	0.212	0.207	-0.079	0.082	.289*	-0.083	.410**	0.192	.375**	0.233	.437**	.310*	0.220	0.204	--

Note. *Correlation significant to 0.05 level (2-tailed) **Correlation significant to the 0.01 level (2 tailed) Listwise n=49 (all post-survey respondents). Significant moderate to strong correlations in bold.

Table E-2: Spearman's rank correlation matrix. Correlation between final mark and subscales of the MSLQ in Phase 3

		Final	Motivation subscales						Learning strategy subscales									
		Mark	IN	EX	SE	CL	TV	TA	RH	EL	OR	CT	PL	MR	ER	TE	HS
Motivation subscales	Intrinsic (IN)	.328*	--														
	Extrinsic (EX)	0.076	0.176	--													
	Self-efficacy for learning (SE)	**.589****	**.701****	0.240	--												
	Control of learning beliefs (CL)	.343*	.436**	0.225	.484**	--											
	Task Value (TV)	.422**	**.653****	.365**	**.663****	**.589****	--										
	Test Anxiety (TA)	-.402**	-0.243	0.268	-.456**	-0.068	-0.118	--									
Learning strategy subscales	Rehearsal (RH)	0.159	0.183	0.188	0.127	.279*	0.116	.336*	--								
	Elaboration (EL)	.303*	.446**	0.181	0.266	0.224	.366**	-0.150	0.199	--							
	Organisation (OR)	0.188	.483**	0.201	0.239	0.222	.334*	-0.004	.362**	.730**	--						
	Critical Thinking (CT)	-0.055	.372**	0.111	0.208	0.146	0.198	0.074	.285*	0.180	.335*	--					
	Peer Learning (PL)	-0.099	0.157	.390**	-0.001	0.160	0.087	0.108	0.158	0.178	.408**	0.194	--				
	Metacognitive Regulation (MR)	.478**	.466**	.274*	**.597****	.444**	.444**	-.298*	0.259	**.516****	.495**	.358**	.306*	--			
	Effort Regulation (ER)	**.533****	.391**	0.088	.474**	0.124	.282*	-.334*	0.266	.425**	.397**	-0.015	0.092	.455**	--		
	Time & Environment (TE)	**.553****	**.485****	0.052	**.549****	.291*	.465**	-.327*	.328*	.384**	.450**	0.068	-0.039	.457**	**.706****	--	
	Help Seeking (HS)	0.227	0.016	.326*	0.153	0.139	0.086	0.141	0.156	0.090	0.214	0.181	**.504****	.355**	0.234	0.193	--

Note. *Correlation significant to 0.05 level (2-tailed) **Correlation significant to the 0.01 level (2 tailed) Listwise n=52. Significant moderate to strong correlations in bold.

Appendix F – Checklists

Table F-1: Criteria for Describing and Evaluating Training Interventions in Healthcare Professions (CRe-DEPTH) Checklist for Chapter 5

Item	Criterion	Reported on Page
Development of the training		
1	Description of the aim or objectives of the training	79
2	Description of the underlying theoretical framework	64
3	Description of the developmental process	65
4	Description of the target population and setting of the training	63 + 77
5	Description of the educational resources	72
Characteristics of the training		
6	Description of the content of the training	73-76
7	Description of the format	73-76
8	Description of the didactic methods of training	73-76
9	Description of the tailoring of the training	73-76
Characteristics of the providers/trainers		
10	Description of the providers of the training	79
Assessment of the training outcomes		
11	Description of the measured outcomes	81
12	Description of the applied assessment method, including validity and reliability.	83

Note: Listed on the Enhancing the QUAlity and Transparency of health Research (EQUATOR) Network Adapted from "Criteria for describing and evaluating training interventions in healthcare professions – Cre-DEPTH" by A. van Hecke, V Duprez, P. Pype, D. Beeckman, and S. Verhaeghe, 2020, *Nurse Education Today, 84 104254. (https://doi.org/10.1016/j.nedt.2019.104254)*

Table F-2: Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist for Chapter 7

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/ facilitator	Which author/s conducted the interview or focus group?	107
2. Credentials	What were the researcher's credentials? e.g., PhD, MD	107
3. Occupation	What was their occupation at the time of the study?	107
4. Gender	Was the researcher male or female?	107
5. Experience and training	What experience or training did the researcher have?	107
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	106
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g., personal goals, reasons for doing the research	106
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g., Bias, assumptions, reasons, and interests in the research topic	
Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study?	107
Participant selection		
10. Sampling	How were participants selected? e.g., purposive, convenience, consecutive, snowball	105
11. Method of approach	How were participants approached?	105
12. Sample size	How many participants were in the study?	105
13. Non-participation	How many people refused to participate or dropped out? Reasons?	105
Setting		
14. Setting of data collection	Where was the data collected	106
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	106
16. Description of sample	What are the important characteristics of the sample? e.g., demographic data, date	106
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	107
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	106
19. Audio/ visual recording	Did the research use audio or visual recording to collect the data?	106

20. Field notes	Were field notes made during and/or after the interview or focus group?	108
21. Duration	What was the duration of the interviews or focus group?	106
22. Data saturation	Was data saturation discussed?	
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	106
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	one
25. Description of the coding tree	Did authors provide a description of the coding tree?	110
26. Derivation of themes	Were themes identified in advance or derived from the data?	107
27. Software	What software, if applicable, was used to manage the data?	108
28. Participant checking	Did participants provide feedback on the findings?	No 106
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g., participant number	Yes
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31. Clarity of major themes	Were major themes clearly presented in the findings?	Yes
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Yes

Note. Adapted from “Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups” by A. Tong, P. Sainsbury and J. Craig, 2007, *Internaltional Journal for Quality Health Care* 19(6):349-357 (http://doi.org/10.1093/intqhc/mzm042)

Appendix G – Examples of teaching and learning resources.

Goal setting: Provide students with learning outcomes

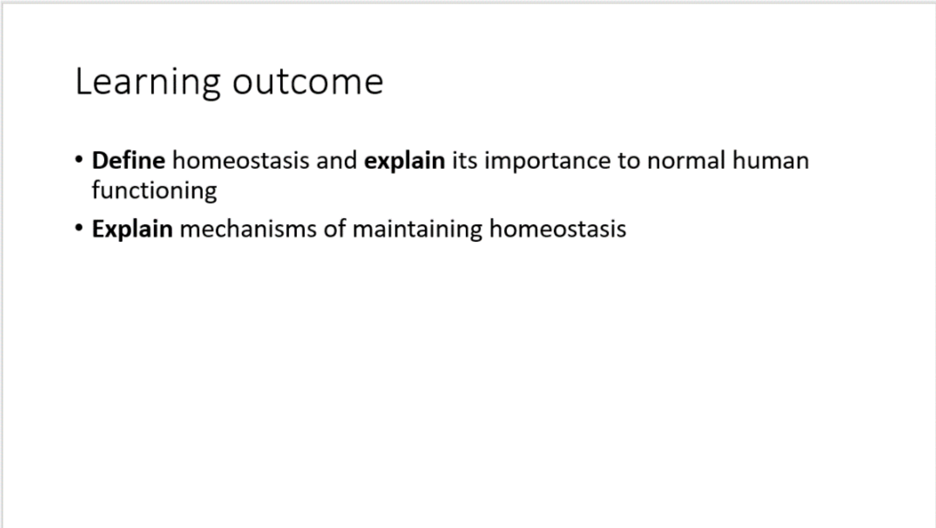

Figure G-1: Learning Outcomes for Module 2

Task analysis

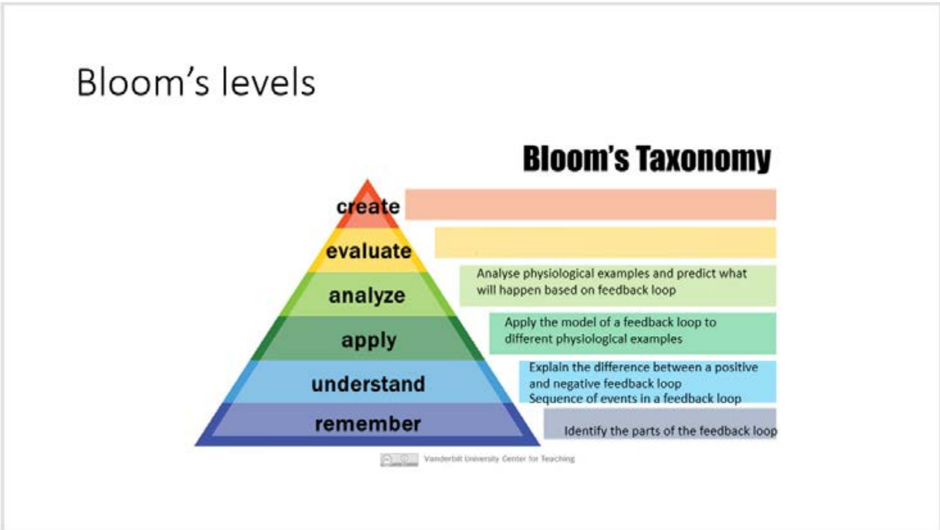

Figure G-2: Explanation of expectations of the learning outcomes in terms of Bloom's Taxonomy of Cognitive Thinking

Task Verbs

Assessment tasks will always contain a task verb, which is the key to understanding what you are meant to do. For example:

- **Identify** the vessels and valves of the heart
- **Describe** the path of the blood through the heart
- **Explain** the role of the valves of the heart

are all very different questions, but parts of their answers will be the same, all of them will require the names of the valves. However, as we go down the list, more details are required to get the full marks.

Word	What you need to do ...
Analyse	Break the information into its parts; examine the relationship between the parts; question the information
Compare	Identify the characteristics two or more things have in common (may need to point out differences as well)
Contrast	Point out the differences between two things (may need to note similarities as well)
Define	Make a statement about the meaning or interpretations of something, giving sufficient detail to allow it to be distinguished from similar things
Describe	Spell out the main aspects of an idea or topic or the sequence in which a series of things happen
Distinguish	Highlight the differences between two (possibly confusing) items
Explain	Your main focus should be on the 'why' or 'how' with the aim of clarifying reasons, causes and effects
Identify	Provide a specific answer (eg a name or key feature), does not need an explanation
Illustrate	Similar to explain, but asking for specific examples
List	Give an itemised series, answers should be concise
Outline	Organised description: give main points and essential information. Present the information in a systematic arrangement or classification
Predict	Estimate what will happen, as a consequence of the available information
Relate	Emphasise connections and associations in a descriptive manner; cause and effect
Summarise	Provide a brief statement or an account covering the main points; omit details.

Figure G-3: “Know your verbs” learning strategy

Pre-reading

Topic 2: The cell. Homeostasis.

Learning outcomes

- **Describe** the structure of the animal cell
- **Describe** the function of each organelle
-
- **Define** homeostasis and **explain** its importance to normal human functioning
- **Explain** mechanisms used by the body to maintain homeostasis

In this topic we will take a close look at what is inside an animal cell. We will also look at one of the most important concepts in physiology - homeostasis.

Week 2 Checklist.pdf

Before the lecture:

1. Skim read the textbook chapter - note the headings/subheadings, check the images - try to work out what the focus of the lecture will be. This will help your brain be prepared for the lecture. Note any words that are new, so they don't trip you up during the lecture.
2. Think of some questions you need answers to.

After the lecture:

1. revise the notes you took during the lecture - do this ASAP, or you might forget what your notes mean
2. did you get the answers to your questions?
3. use the textbook and your notes to help you *write a summary in your own words*
4. complete the revision questions at the end of the chapter
5. if you still don't have the answers to your questions, seek help via the class conversations or email.
6. try out some of the learning strategies during your study sessions this week.

Before the practical

1. Pre-read the appropriate practical information for the week

Figure G-4: Introductory section of Module 2 showing the suggested pre-reading strategy for priming before the theory sessions.

Flashcards

LEARNING STRATEGIES

Each week I will introduce you to a learning strategy or two that you might find useful when studying anatomy and physiology.

Flashcards

I am providing two videos for this learning strategy. The first tells you how to use quizlet to make and use flashcards. Quizlet is available on the web or by app. It is good if you find yourself sitting around for a few minutes in a waiting room, or waiting for kids. When you begin learning something new, there is always a phase where you must become familiar with terms, repitition is the best way to learn this type of information. It's also good to start trying to use the words in their proper context - so try making up some sentences.

How to use Quizlet : https://youtu.be/Jo6lTr9yt4Y

This second video is about making your own flashcards and linking new knowledge with something that you already know. This is a great technique to use whenever you are learning new information. You have already learned many things in your life, and whenever you try to learn new information, you have to find a "place" for it inside the knowledge you already have. If it is something totally new, it can be harder to learn because it doesn't already have a place to fit into. So, if you can "pin" it to something you do know, then it will stick better.

How to study effectively with flashcards: https://youtu.be/mzCEJVtED0U

Figure G-5: LMS page for flashcards learning strategy. This website is ancillary to the explicit teaching and practice of the strategy during class.