Self-regulated learning strategies for first year chemistry students during Covid-19

A mixed methods study

Submitted in partial fulfilment of the degree MSc Science Education in the Department of Chemistry in the Faculty of Natural and Agricultural Sciences at the University of Pretoria

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ABSTRACT

The Covid-19 pandemic forced higher education institutions to shift from face-to-face to online learning, which presented several challenges such as lack of access to fast, affordable, and dependable internet connections and suitable devices. The unexpected shift to online learning because of the pandemic required students to be skilled in self-regulated learning (SRL) to produce good academic outcomes. Previous research has concentrated on the use of SRL strategies in online settings; however, the use of SRL strategies in an unplanned online learning environment created during the Covid-19 pandemic is novel; thus, the current study aims to investigate the use of SRL strategies in an online learning environment during the Covid-19 pandemic for a first-year chemistry course and identify SRL strategies associated with success.

SRL was defined as the degree to which students are metacognitively, motivationally, and behaviourally active participants in their own learning process (Zimmerman & Schunk, 2001). SRL theory served as the theoretical framework for this study. A case study methodology with a mixed methods design was used. For quantitative data collection, the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993) was supplemented with questions from the Online Self-regulated Learning Questionnaire (OSLQ) (Barnard et al., 2009) to include questions specific to the online learning. The two instruments were adapted to yield an instrument with 61 items that was administered with a 4- point Likert scale for data collection. Statistical analysis was done using both SPSS and RUMM2030. Qualitative data was collected by means of a follow-up survey to enrich the quantitative results and thematic analysis was conducted.

430 students out of a class population of 1370 responded. It was found that students frequently used learning strategies such as environment structuring, effort regulation, and elaboration, whereas critical thinking, task strategies, help seeking, and peer learning were reported to be used less frequently. An independent t-test analysis revealed that students who passed the exam reported higher use of effort regulation, goal setting, and time management, whereas those who failed the exam reported higher use of critical thinking and peer learning.

A Rasch analysis of the data was performed to investigate the instrument's quality for measuring purposes. Some items revealed misfit and were deleted, while others were rescored to correct the misfit. The instrument was only deemed valid and reliable after some items were removed and others were rescored, and after items were grouped into their respective subscales, with the *help seeking* and *peer learning* subscales removed.

Students reported poor use of task strategies, help seeking, and peer learning. A follow-up qualitative survey revealed that this failure to engage with these strategies was due to factors such as confusion, fear, and isolation because of lockdown. It can be concluded that during the pandemic, effort regulation, goal setting, and time management were associated with success in first-year chemistry. Furthermore, the lockdown regulations influenced the use of task strategies, peer learning, and help-seeking strategies. As a result, there is a need to provide a safe environment for students to ask questions as well as opportunities for them to connect with their peers.

PLAGIARISM DECLARATION

I declare that the dissertation which I hereby submit for the degree of MSc Science Education at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at another university. Where secondary material is used, this has been carefully acknowledged and referenced in accordance with university requirements. I am aware of university policy and implications regarding plagiarism.

SIGNATURE: ……. DATE: 30 NOVEMBER 2021

L RAKHUNWANA

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CHAPTER 1: INTRODUCTION TO THE STUDY

The initial motivation for this study is discussed in this chapter. The chapter builds on the significance of such a study by explaining the study's context and participants. After explaining the rationale, the first chapter ends with a concise goal of the study and research questions, accompanied by an overview of the remaining chapters in this study.

1.1 MOTIVATION FOR THE STUDY

When I first began as a first-year chemistry student at the University of Pretoria, it was one of the most exciting times of my academic career. However, I found the transition from high school to university to be challenging. Apart from adapting to a new socially diverse environment, I struggled to adapt to the new teaching and learning methods and struggled to establish successful learning strategies. Fortunately, while there was still time, I was able to find out what study patterns worked best for me and completed my first-year courses successfully. However, not all students are able to establish learning strategies that work for them in time to successfully complete the courses; some drop the courses completely, while others fail. This motivated me to pursue this research project, and I hope that the results of this study will help improve the academic success of future first-year chemistry students. Nonetheless, I understand that poor use of learning strategies is not the only reason students perform poorly and, in some cases, drop out; there are other both internal and external factors that lead to students' failure to successfully complete their first-year modules.

1.2 CONTEXT OF THE STUDY

This study took place at the University of Pretoria in the department of chemistry. The module of interest was CMY 127, a first-year general chemistry course. Every year, approximately 1500 students enrol in the module. This module enrols students of various ethnicities, languages, and academic backgrounds. The module is offered at the Hatfield campus of the University of Pretoria. CMY 127 is a mandatory module for students pursuing a chemistry degree as well as other science degrees such as biology and physics. This is a second-semester module that builds on a first-semester module (CMY 117: General chemistry). CMY 127 draws heavily on the knowledge gained in CMY 117 during the first semester, as well as some content covered in grade 12 but in greater depth and detail. The module is divided into two sections, each with its own set of lecturers, practicals, tutorials, and online assignments. **Figure 1.1** shows content delivered in each of the two sections of the module.

Section 1: Analytical and physical chemistry	Section 2: Organic chemistry
• Chemical equilibrium • Acids and bases, buffers and solubility equilibrium, • Entropy and free energy • Electrochemistry • Practical: Chromatography, solubility and chemical equilibrium	• Structure (bonding), nomenclature, isomerism, introductory stereochemistry • Introduction to chemical reactions and chemical properties of organic compounds and carbohydrates. • Practical: Molecular structure (model building), synthesis and properties of simple organic compounds

Figure 1.1: Content delivered in the two sections of CMY 127.

Under normal circumstances, students would be expected to attend four 50-minute lectures each week. Students would also be expected to attend one 3-hour practical session every two weeks and a 3-hour tutorial session in the week wherein they do not have a practical session, for a total of six practical and six tutorial sessions throughout the semester. However, due to the change to online learning because of the pandemic students are now given an opportunity to attend a 1-2-hour tutorial session every week and not once every two weeks and complete online "practical" activities in their own time. Module activities are currently all conducted online, with lectures delivered via Blackboard live virtual lectures with a discussion board platform to allow students to interact outside of formal lecture time.

As part of their formal assessment, students take six class tests, three semester tests, and one final examination. Each section of the module has its own collection of computer-based homework assignments that students must complete to facilitate independent self-work. Homework is completed online, and grades are automatically given. A minimum semester mark of 40% is required for a student to be admitted to the final examination. The assessments that occur during the semester contribute the following to the final semester mark: semester tests = 70%, class tests + online homework = 20%, and Practicals = 10%. A final mark used to determine whether a student passes, fails or is admitted for a re-examination is calculated as the arithmetic mean of the semester mark and the examination mark, that is 50% of the semester mark and 50% of the examination mark. A minimum final mark of at least 50% is required for a student to pass the module.

1.3 PROBLEM STATEMENT

All post-secondary institutions share the vision of high throughput rates coupled with low dropout rates. Nonetheless, high dropout rates of students in their first year and subsequent years of study have been observed in most post-secondary institutions over the years (Kritzinger, Lemmens, & Potgieter, 2018). Many students struggle in their first year of university with developing learning strategies that are appropriate for the modules they are enrolled in, including chemistry. It is well known that good learning strategies are attributed to good performance (Broadbent, 2017); thus, a lack of appropriate learning strategies can result in students performing poorly in their academics. As a result, some students drop out during their first year or the subsequent years. In addition, the Covid-19 pandemic added to the challenges that students were

already facing. The lockdown restrictions, which resulted in learning suddenly moving online, presented challenges for our students. Students had to figure out an appropriate study skills for chemistry in addition to navigating the new learning mode. Therefore, this study investigates students' self-reported use of learning strategies in an online first-year chemistry module. Learning strategies associated with success will be established as a result of this study, and they will be used to inform the design of interventions to academically benefit first-year chemistry students and direct them toward being better self-regulators of their own learning.

1.4 RATIONALE FOR THE STUDY

Learners' lack of readiness for post-secondary education influences their academic performance once they enrol in universities. Furthermore, when learners transition into post-school education they should ensure that they survive school transitions and stay on track for good academic performance, as failure to do so may result in higher attrition rates in tertiary education institutions. Research shows that economically and educationally deprived students are particularly vulnerable to transition difficulties when transitioning from high school to university (Petersen, Louw, & Dumont, 2009; Sennett, Finchilescu, Gibson, & Strauss, 2003). With that being said, to achieve good academic performance in university, appropriate learning strategies are needed whether learning is delivered face-to-face, online, or in a blended learning setting. By the time they begin their first year at university some students have already developed learning strategies that work for them; however, most students continue to struggle with establishing learning strategies that work for the modules in which they are enrolled. In such instances, these students end up performing poorly academically and, as a result, drop out of university.

Poor use of learning strategies is not the only reason students may drop out of a university. According to Lewin and Mawoyo (2014), factors that lead to high dropout rates in South African universities are complex and multi-dimensional, and they have divided these factors into social and academic factors. The following is their explanation for these factors: Social factors that influence success and performance include schooling history, socioeconomic status, race and gender, and the social context of learning. Academic factors influencing success are student and academic staff-related, and include pedagogy, language and literacy, teaching and assessment methods, and curriculum structure. Other studies have shown that insufficient preparation for the academic demands of higher education, financial pressures, unpleasant academic experiences, a lack of adequate integration into the dominant higher education community, and a range of personal traits all have a negative effect on students' performance and thus lead to high dropout rates in South African universities (Manik, 2014; Van Zyl, 2015; Thomas & Maree, 2021). Moodley and Singh (2015) investigated ways to minimize dropout rates in South African universities. According to their findings, the major contributors to high dropout rates are affordability, a lack of academic support, a lack of career guidance, a lack of self-discipline, and a lack of commitment. As a result, by addressing these issues, the high dropout rate challenge may be alleviated. Holding all these factors in mind, this study focuses on those related to how students conduct themselves academically, that is the learning strategies that students use.

According to the studies cited above, even prior to the Covid-19 pandemic and the associated lockdown restrictions, South African higher education institutions faced the challenge of high dropout rates. Thus, the implementation of Covid-19 lockdown restrictions, which forced universities to move from face-to-face (or blended) to online learning, intensified the situation because students then had to deal with not only the new university environment and developing learning strategies that work for them, but they also had to deal with the unforeseen online learning environment (Adedoyin & Soykan, 2020). This meant that, in addition to the issues that influenced students' academic performance under normal conditions, there were Covid-19-related issues, such as pandemic-related anxiety and resource inequalities due to different socioeconomic backgrounds (Adedoyin & Soykan, 2020; Dube, 2020; Marongwe, Kariyana, & Mbodila, 2020). Consequently, the rationale behind this study was to learn about how students behaved academically in a first-year chemistry course at the University of Pretoria amidst the Covid-19 pandemic. This was accomplished using a survey to gather information about the students' study patterns in the first-year chemistry course. The information obtained will be used to advise both institutional and curriculum-based support activities (e.g., student advising and curriculum design) in order to assist students in becoming more self-regulated and employing effective learning strategies.

1.5 AIM OF THE STUDY

The main aim of this research was to explore students' use of learning strategies during the Covid-19 pandemic while studying online to identify the learning strategies associated with success in a first-year chemistry course.

1.6 RESEARCH QUESTIONS

The researcher set out to address the following research questions during the course of this study:

1. Which learning strategies were reportedly used more frequently by students, and which were reportedly used less frequently?
2. Which learning strategies differentiated between the strongly performing and poorly performing students?
3. How did online learning as a result of the lockdown restrictions affect students' use of learning strategies?

1.7 SEQUENCE OF THE RESEARCH REPORT

The report began with an introduction to the study that outlined the motivation for the study, context, and rationale. The second chapter provides a literature review on the theory that guides the study. The third chapter contains the methodology and methods for the study. The chapter provides technical details on how the study was carried out by presenting data collection tools and data analysis methods. Chapter 3 also covers ethical considerations. Before delving into the suitability of the survey tool to make inferences, Chapter 4 presents the preliminary findings of the study. The fifth chapter presents the main results of the study, from which inferences can be drawn. This is followed by the sixth chapter, which expands on the results reported

in chapters four and five. The final chapter contains a summary of the findings, the implications and significance of the study, some ideas for future work, and concluding remarks.

1.8 SYNTHESIS

The high dropout rates in South African universities were discussed in this chapter, and a lack of appropriate learning strategies was identified as one of the factors contributing to the problem. The motivation of the researcher for the study was the poor academic performance of the students due to poorly developed learning strategies. Therefore, the aim of the study was to identify learning strategies associated with success in order to guide students who enroll in the module in the future to become better self-regulated in their learning and ultimately improve their academic performance. The following chapter delves into self-regulated learning theory and the use of self-regulated learning strategies in various learning environments and how this is related to student academic performance.

CHAPTER 2: LITERATURE REVIEW

This chapter begins with a theoretical framework for the study and then moves on to a review of the literature on self-regulated learning and academic performance. Following that, the literature on self-regulated learning strategies in a blended learning environment is reviewed. This section also reviews studies that compared the use of self-regulated learning strategies in a blended learning environment to either face-to-face or online learning environments. Some literature on the advent of online learning due to Covid-19 is presented followed by a review of literature on self-regulated learning in an online learning environment. Following that, a review of the research instruments used to assess self-regulated learning is given. The chapter concludes with a summary of the key findings from the literature, identifying a gap and outlining how this study intends to fill it.

2.1 THEORETICAL FRAMEWORK

A theoretical framework can be defined as a structure that steers research by relying on a formal theory which is built by using an established, coherent explanation of phenomena and relationships. Therefore, the theoretical framework consists of a chosen theory that serves as the primary means by which the research problem is understood and investigated; that is, the theory underpins the researcher's thinking about how to research a topic, along with the concepts and definitions from that theory that are applicable to the topic (Osanloo & Grant, 2016). The framework provides structure and support for the rationale of the study, problem statement, aim, significance, research questions, methodology, data collection and data analysis (Lester, 2005; Lederman & Lederman, 2015).

Self-regulated learning theory

Self-regulated learning (SRL) theory serves as the theoretical framework in this study. Self-regulated learning theory stems from the social-cognitive learning theory of Albert Bandura which states that people learn new behaviours by observing a model, and that personal cognitive factors, the behaviour itself, and the environment are all involved in a triadic feedback relationship known as reciprocal determinism, which influences the replication of the learned behaviour. Personal factors that influence learning and behaviour include learner's beliefs and attitudes whereas access to information, quality of instruction and teacher feedback are all environmental factors. Among the behavioural factors are the response an individual receives from a teacher after performing a behaviour and the effects of the behaviour itself (Bandura, 1997).

Social cognitive learning theory views self-regulated learning as a process in which individuals learn to become self-regulated by progressing through four levels of development: observational, imitative, self-controlled, and finally, self-regulated (Schunk, 1996; Zimmerman, 2000). Modelling is the centre of observational learning, whereas social guidance and feedback are the focus of imitative learning. Both levels emphasize a dependence on external social elements. At the self-controlled level, students develop internal criteria for satisfactory performance and become self-reinforcing through encouraging self-talk and feedback. At the self-regulatory level, individuals with high self-efficacy beliefs and a vast range of cognitive

strategies can self-regulate their learning (Schraw, Crippen, & Hartley, 2006). Students become increasingly reliant on internal, self-regulatory capabilities as they mature.

There are a variety of definitions that have been used to describe SRL. Zimmerman (1989) defined SRL as the degree to which students are active participants in their own learning process in terms of metacognition, motivation, and behaviour. SRL was characterized by Dowell and Small (2012) as a conscious decision made by students to attain specific goals, develop strategies to attain those goals, and their willingness to modify established strategies. Cho, Kim, and Choi (2017) defined it as a process in which learners systematically manage their learning process in a way that it improves their motivation and reflection, and thereby helps them reach their own goals. These definitions emphasize the idea that students are in control of their own learning processes and can transform mental ability into task-related skills in a variety of contexts, including academics. In attempting to explain the processes and subprocesses involved in SRL, various models have been developed over the years by different researchers, for example, cyclical phases model by Zimmerman (2000), and Pintrich's SRL model (Pintrich, 2000).

The cyclical phases model by Zimmerman (2000) has three phases: forethought, performance, and self-reflection. During the forethought phase, students examine the task, establish strategic goals, and plan how to achieve them. In this phase, a variety of motivational beliefs energise the process and drive the activation of learning strategies. In the performance phase, students perform the task while monitoring their progress and use a variety of self-control strategies to keep themselves engaged to complete the task. Lastly, during the self-reflection phase, students evaluate their performance and try to determine the cause for their success or failure. These attributions trigger self-reactions that can have a good or negative impact on how students approach subsequent tasks.

Pintrich's SRL model is comprised of four phases: (i) forethought, planning, and activation; (ii) monitoring; (iii) control; and (iv) reaction and reflection. Each of the phases has four different areas for regulation: cognition, motivation/affect, behaviour, and context. This combination of phases and areas provides a comprehensive picture of SRL processes that are incorporated in the phases. For example, under the monitoring phase, activities for the four areas of regulation would be metacognitive awareness and monitoring of cognition; awareness and monitoring of motivation and affect; awareness and monitoring of effort, time use, and need for help; and finally monitoring changing task and context conditions (Pintrich, 2000). Despite differences in terminology, both models hold the assumption that SRL progresses from a preparatory or preliminary phase to performance or task completion and then to an appraisal or adaptation phase. In the preparatory phase, task analysis, planning, and goal setting occur; in the performance phase, the actual task is completed while monitoring and controlling the progress of performance; and in the appraisal phase, the student tends to reflect, and adapt for future performances (Puustinen & Pulkkinen, 2001; Panadero, 2017).

Zimmerman (2000) and Pintrich's (Pintrich, 2000) SRL models may be beneficial in academic interventions to improve student academic performance. In these models, SRL has distinct phases and subprocesses which would allow for more targeted interventions because measuring the impacts may be simpler. For example, if an instructor notices that one of her students is struggling with a task, implementing some of Zimmerman's subprocesses, such as self-observation, at that stage may result in a positive outcome. Other SRL models, such as Winne's SRL model (Winne & Hadwin, 1998) and Boekaerts' (2011) dual processing self-regulation model, may offer more comprehensive interventions since they view SRL as a more continuous process with more inertially connected subprocesses. However, more research would be required to investigate these theories.

2.2 RESEARCH INSTRUMENTS

There are currently several instruments used to assess SRL strategies which can be classified into retrospective and "during the learning process" instruments (Veenman, 2011). Retrospective instruments inquire about previous SRL strategies use, while "during the learning process" instruments are focused on process models and are used to investigate the SRL process itself as it occurs. In the "during the learning process" instruments participants describe decisions made during task performance or are observed during task performance. Therefore, rather than examining whether a learner possesses specific SRL strategies, "during the learning process" instruments assess whether a learner can use their SRL competencies (Roth, Ogrin, & Schmitz, Assessing self-regulated learning in higher education: a systematic literature review of self-report instruments, 2015).

The think-aloud method (Van Someren, Barnard, & Sandberg, 1994), reflect when prompted method (Bannert & Mengelkamp, 2007), observation of online activities, eye movement registration (Henderson, Luke, Schmidt, & Richards, 2013) which records eye movements during task performance, and log file registrations using computer software to automatically record learner activities on the computer (Veenman, 2011) are all examples of "during the learning process" instruments used for data collection. The "during the learning process" assessment procedure has the benefit of recording ongoing SRL strategies as they are applied rather than recalling them after the task is completed (Boekaerts & Corno, 2005). Some disadvantages may include participants' inability to correctly express their inner thoughts; additionally, students may require extensive practice before they can handle the dual task; and the additional task of reporting one's cognitions and feelings may conflict with the target task, resulting in high cognitive load and bias (Boekaerts & Corno, 2005; Veenman, 2011).

Self-report questionnaires, on the other hand, are used as retrospective instruments to collect data on self-regulated learning. To assess the frequency of reported strategy use, these questionnaires use Likert-type scales (Boekaerts & Corno, Self-Regulation in the Classroom: A Perspective on Assessment and Intervention, 2005). Self-report questionnaires have the advantage of not interfering with students' learning

experiences and are simple to administer in large-scale testing. However, one drawback could be that students are unable to recall their actions accurately (Schellings & Van Hout-Wolters, 2011).

In their review of the use of self-report instruments for investigating use of learning strategies, Roth, Ogrin, and Schmitz, (2016) found that only 7.56 % of studies used "during the learning process" instruments, indicating that most studies used retrospective instruments. The review also revealed that instruments such as the Motivated Strategies for Learning Questionnaire (MSLQ), Learning and Study Strategies Inventory (LASSI), Inventory of Learning Styles (ILS), Academic Self-Regulated Learning Scale (A-SRL-S), Online Self-Regulated Learning Questionnaire (OSLQ), Self-efficacy for Learning Form (SELF), Self-efficacy for Self-Regulated Learning scale (SESRL) and Self-Regulated Learning Interview Schedule (SRLIS) were commonly used instruments in academic literature, with the MSLQ being the most commonly used.

The MSLQ is a self-report instrument for assessing university motivational orientations of students and use of various learning strategies. It was developed to assess the presence of SRL in a specific university course (Pintrich, Smith, Garcia, & McKeachie, 1993). The MSLQ was created using a social-cognitive perspective of motivation and learning strategies (Duncan & McKeachie, 2005). This 81-item instrument employs a 7-point Likert scale (1 = not at all true of me and 7 = very true of me); it is divided into two sections: a motivational section and a section on learning strategies. The motivation section assesses the student's goals, values, beliefs, skills to excel in the course, and anxiety about writing tests and exams. The subscales on learning strategies evaluate cognitive and metacognitive strategies used in the course, as well as the management of various resources (Pintrich, 1991). When the MSLQ was developed, the Cronbach's alpha values ranged from 0.52 to 0.93 (Pintrich, 1991). The validity and reliability of the MSLQ have been investigated by various researchers (Cho & Summers, Factor validity of the Motivated Strategies for Learning Questionnaire (MSLQ) in asynchronous online learning environments, 2012; Feiz & Hooman, 2013; Lee, Zhang, & Yin, 2010) since its development, and the questionnaire has also been translated into various languages (Zurita Ortega, Martinez Martinez, Chacon Cuberos, & Ubago Jiménez, 2019; Khosim & Awang, 2020; Olivari, Bonanomi, Gatti, & Confalonieri, 2015, July). Although it does not assess post-action strategies such as self-reflection and regulation, Roth, Ogrin, and Schmitz, (2016) highlighted two reasons why the MSLQ is still widely used: (i) It provides a reasonably good balance between differentiated assessment and cost-effective implementation, and (ii) it assesses motivation in a sophisticated way. In his review of the MSLQ in 2005, Artino outlined some of the MSLQ's reported advantages. These advantages include the fact that the MSLQ is in the public domain, is cost-effective to deliver, is easy to score, and it was explicitly designed for undergraduate students to investigate their self-regulated learning as it relates to a particular unit of study (Artino Jr, 2005).

Barnard, Lan, To, Paton, and Lai (2009) worked on finding an instrument to assess the use of self-regulated learning strategies in the online learning environment and developed the Online Self-regulated Learning Questionnaire (OSLQ). The OSLQ initially had 86 items and was created based on Zimmerman's self-

regulated learning model (Lan, Bremer, Stevens, & Mullen, 2004). Goal setting, task strategies, self-instruction, time management, self-monitoring, self-evaluation, self-consequences, environmental structuring, and help seeking were some of the most studied self-regulated learning skills, according to Zimmerman and were used as basis to develop the OSLQ instrument. The development of the 86-item OSLQ involved asking students who were taking online classes to share the skills and strategies they used to self-regulate their learning. The interviews were used to generate items for the OSLQ instrument, and the interviewing process was repeated until each category had at least 8 items. Confirmatory factor analysis was used at the level of the subscales as well as the whole instrument to validate the categories (Lan, Bremer, Stevens, & Mullen, 2004). Eventually, the OSLQ was shortened to consist of 24 items with a 5-point Likert response format ranging from strongly agree (5) to strongly disagree (1). The 24-item OSLQ consists of six subscale constructs including: environment structuring; goal setting; time management; help seeking; task strategies; and self-evaluation (Barnard, Lan, To, Paton, & Lai, 2009).

Barnard, Lan, To, Paton and Lai (2009) investigated the reliability and validity of the OSLQ in the online and blended learning settings. The instrument's scores showed satisfactory internal consistency, with a Cronbach alpha value of 0.90. When using Cronbach's alpha values as a measure of reliability in basic social science research, Nunnally (1978) and Kline (2015) indicated that score reliability of 0.70 or better is sufficient. When looking at the reliability of each subscale, Cronbach alpha values ranged from 0.67 to 0.90, suggesting adequate subscale score reliability and indicating that the OSLQ is an appropriate measure of self-regulation in online and blended learning environments. The OSLQ constructs were also found to be reliable in another study that explored the relationship between learner motivation and self-regulated learning among secondary students in an online dual enrolment agriculture course. The Cronbach's alpha values ranged from 0.87 to 0.94 (Swafford, 2018). Vilkova and Shcheglova (2021) used confirmatory factor analysis to assess the OSLQ's construct-related validity in Russian massive open online courses (MOOCs) in a separate study. The findings showed that the original six subscales model did not fit the data, with evidence that the help seeking subscale was ineffective in a MOOC setting. The other five OSLQ subscales, on the other hand, were found to fit the data (Vilkova & Shcheglova, 2021). The misfit of the help seeking subscale was reasonable because in a MOOC setting, students have little opportunities to interact with one another and with the instructors. As a result, a five-factor OSLQ was proposed. Nonetheless, the OLSQ has grown in popularity in recent years and is now a commonly used instrument to assess SRL skills in the online learning environment; it has been applied to both cross-sectional (Kintu & Zhu, 2016) and longitudinal research (Onah & Sinclair, 2016). It has also been translated into Turkish (Korkmaz & Kaya, 2012), Romanian (Cazan, 2014), Russian (Martinez-Lopez, Yot, Tuovila, & Perera-Rodríguez, 2017), and Chinese languages (Fung, Yuen, & Yuen, 2018).

Overall, this section emphasizes the availability of various instruments that researchers use to assess SRL, the merits of which are excluded from this review since the instruments were not utilised in the current study. However, as demonstrated in this section, the MSLQ and OSLQ instruments are commonly used to assess

SRL in face-to-face (MSLQ) and online and blended learning (OSLQ) settings. These two instruments were then selected as data collection instruments for the current study (see section 3.3).

2.3 SRL AND ACADEMIC PERFORMANCE

Academic performance, also referred to as academic achievement, is the extent to which a student has reached learning goals set by the institution, and it is often evaluated through exams, tests, or continuous assessments (Ganai & Mir, 2013). Previous studies have shown that students skilled in self-regulated learning perform better than those who are poorly self-regulated (Pintrich, 2000; Barnard-Brak, Paton, & Lan, 2010; Olakanmi & Gumbo, 2017).

Post-secondary education, in contrast to students' experiences in primary and secondary school, demands or expects students to be more proactive, retain motivation, set goals, and use learning strategies to succeed academically (Banarjee & Kumar, 2014; Ramnarain & Molefe, 2012). However, most students arrive at post-secondary institutions lacking fundamental skills such as goal setting, time management, stress management, and seeking help when needed (Lopez, Nandagopal, Shavelson, Szu, & Penn, 2013). Schraw et al. (2006) stated that students who are proficient in SRL can set goals, choose strategies to help them reach those goals, put those strategies into action, and track their progress toward those goals. Therefore, goal setting is a necessary skill across the various phases of self-regulation: forethought (setting a goal and deciding on goal strategies); performance control (using goal-directed actions and monitoring performance); and self-reflection (assessing one's goal progress and adjusting strategies to ensure success) (Zimmerman, 2000). Thus, a skill such as goal setting is associated with self-regulated learning and ultimately good academic performance.

Miller (2015) investigated how students in an urban two-year college used self-regulation strategies in a first year General Chemistry course and whether their self-reported strategies correlated with performance on a course exam. The MSLQ was used as a data collection instrument and the learning strategies investigated were metacognitive self-regulation, management of time and study environment, effort regulation, peer learning and help seeking strategies. The learning strategies scores obtained were used to predict students' percentage score on a final course exam. There were weak but significant positive correlations found between actual exam score and the MSLQ subscales of metacognitive self-regulation, time and study environment management, and *peer learning*. Furthermore, students who reported high levels of metacognitive self-regulation reported better time and effort management skills. These findings imply that assisting this student population in developing time, effort, and resource management skills should enhance their performance. This was also supported by several studies that found a positive correlation between academic achievement and cognitive and metacognitive strategies (Silagyi-Rebovich, Brooks, & Peterson, 1998), time management (Britton & Tesser, 1991), environment management (Zimmerman & Pons, 1986), effort regulation (Chen C. S., 2002), and help seeking (Silagyi-Rebovich, Brooks, & Peterson, 1998).

A study in Malaysia involving 460 second-year engineering students investigated the ability of SRL to predict academic achievement using the MSLQ as a data collection instrument (Kosnin, 2007). The data collection included both the motivation and learning strategies sections. The results revealed that resource management strategies, test anxiety, metacognitive learning strategies, and self–efficacy were significant predictors of academic achievement. Except for self-efficacy, all these variables had positive influence on academic achievement. In the same study, students were divided into two groups: high achievers and low achievers, and the use of learning strategies by the two groups was compared. Overall, high achievers were found to be better SRL users than low achievers. Among the high achievers, those who had greater control over their learning beliefs and used more resource management strategies but had lower self-efficacy performed better. Resource management strategies such as time and study environment, effort regulation, peer learning, and help seeking, appeared to be strong predictors of good performance within this group. Within the low achieving group, students who reported greater use of metacognitive learning strategies, increased test anxiety, poor internal control over learning, and low task value performed better. This showed that low achievers performed better when they were slightly more concerned about their exams, and when they believed they had less control over their learning and valued the learning task less than their peers in the same achievement group. These factors may have increased their motivation to work harder. According to these findings, it appears that low achievers needed more use of metacognitive learning strategies than high achievers. Hence, individuals within the low achievers who used more metacognitive strategies performed better. Self-regulated learning was also found to explain GPA variance better for high achievers than for low achievers. Among the high achievers, SRL predicted 33.6% of the variance in GPA, and only 13.7% for the low achievers. This suggested that while self-regulation in learning may be a predictor of academic achievement, other factors may be more or equally significant in predicting academic success of students. For example, Raychaudhuri, Debnath, Sen, and Majumder (2010) discovered that students' academic performance may also be predicted by socioeconomic factors such as family income, guardians' education, and distance from school. Several research studies on the impact of peer learning on student performance have been conducted and found that peer learning has more influential effects than family and is positively associated with students' academic success (Gonzales, Cauce, Friedman, & Mason, 1996; Goethals, 2001; Hanushek, Kain, Markman, & Rivkin, 2003). According to Giuliodori, Lujan, and DiCarlo (2006), peer interaction can help students improve their skills in problem solving. Previous research has also shown that factors such as learning facilities, English proficiency, age, and gender differences can all have an impact on students' academic performance both in secondary school and university level (Singh, Malik, & Singh, 2016; Abdullah, 2011).

In terms of English proficiency, some studies have found a positive predictive relationship between English proficiency and academic performance (Geide-Stevenson, 2018; Stoffelsma & Spooren, 2019). Some studies have also found that students who speak English as their first language outperform their peers in schools where English is the medium of instruction (Aina, Ogundele, & Olanipekun, 2013; Kumar, 2014). Other

studies have found a poor to no predictive relationship between English proficiency and academic performance (Crawford & Wang, 2014; Van Rooy & Coetzee-Van Rooy, 2015). Although it does not seem to occur in all settings, English proficiency appears to play a role in students' academic performance.

In terms of gender, there have been research studies that demonstrated that females use slightly different learning strategies than males, which in turn influences their academic performance (Bidjerano, 2005; Hargittai & Shafer, 2006; Zimmerman & Martinez-Pons, 1990; Banarjee & Kumar, 2014). On the other hand, other studies have found that gender differences are insignificant (Astleitner & Steinberg, 2005; Lu, Yu, & Liu, 2003; Yukselturk & Bulut, 2007). Banarjee and Kumar (2014) conducted a study to determine the relationship between SRL and academic achievement for science undergraduate students, as well as the use of SRL strategies by gender. Data were collected using their own questionnaire that assessed learning strategies that fall under four domains: self-motivation, cognition and metacognition, behaviour, and environment. Self-regulated learning and academic achievement were found to be positively correlated. This suggested that students with high self-regulated learning skills were more likely to achieve academic success. Except for the environmental dimension of SRL, no significant differences in the use of SRL strategies were found between male and female science students. This suggested that male and female students were similar in terms of self-motivation, cognition, and behavioural aspects of self-regulated learning, but differed in terms of environmental aspects of self-regulated learning. Zimermann and Martinez-Pons (1990) used interviews to investigate student differences in self-regulated learning in relation to numerous variables, including gender. They discovered that girls are more likely than boys to use self-monitoring, goal setting, planning, and structuring of their learning environment. In another study, Bidjerano (2005) found that female students outperformed male students in their capacity to apply self-regulated strategies such as rehearsal, organization, metacognition, time management, elaboration, and effort, however there were no statistically significant gender differences for peer learning, help seeking and critical thinking. These studies show that there is no consistent difference in the use of learning strategies by gender. It is probable that the difference in the use of learning strategies by gender is influenced by the learning environment, which can be online, blended, or face-to-face. Yukselturk and Bulut (2009) gave an example that female students with heavy family responsibilities, financial stresses, and additional jobs may differ from their male counterparts in the learning strategies they adopt in a distance education online learning environment, and the learning strategies can also differ for female and male students studying in full-time face-to-face courses.

Studies reviewed in this section highlight that there is substantial evidence that the application of SRL strategies is strongly connected with students' academic achievement. Although not always conducted within an SRL framework, there is sufficient research indicating that students who report greater usage of SRL strategies tend to perform better academically.

2.4 SRL AND BLENDED LEARNING

The chemistry module on which the current study is based is normally structured with a blended learning approach. As a result, this section reviews the literature on SRL in a blended learning environment. Blended learning is defined as learning that is assisted by the efficient blending of diverse modalities of delivery, instructional models, and learning styles in a pedagogically beneficial manner (Hrastinski, 2019). According to Hrastindki (2019), blended learning is more than just combining face-to-face and online learning; how much of the two components should be addressed.

Several researchers have classified types of blended learning in various ways, but in this study, we use categorisation by Twigg (2003) since one of the categories fits the blended learning approach in the course under investigation. Twigg (2003) categorised a blended learning approach into four models, namely, replacement model, supplemental model, emporium model and buffet model. The replacement form of blending involves partially or completely replacing face-to-face lectures with online learning opportunities, resulting in fewer face-to-face classes. Contact lectures are frequently replaced by online videos of the lecture. Since face-to-face lectures have been relocated to the internet, class time sessions are typically used to answer lecture-related questions and participate in problem-solving activities. Supplemental type of blending keeps regular class sessions but adds online learning resources. Students must use the additional technology-based learning resources for class preparation, assignments, or deeper engagement with the course content. The emporium form of blending, on the other hand, is designed to replace face-to-face class meetings with a learning resource centre that includes online materials and on-demand personalized support (Twigg, 2003). Interactive tutorials, computational activities, digital hypertext books, practice exercises, answers to frequently asked questions, and online quizzes are all used in this type of blended learning approach. The buffet type of blending is flexible in that it offers a variety of face-to-face and online learning activities from which students can select any combination that best meets their needs, lifestyle, or schedule. The first-year chemistry course in the current study fits the supplemental model of the blended learning approach, consisting of a mix of traditional face-to-face instruction with additional online learning tools and learning supports.

When compared to using a single delivery medium, blended learning offers several benefits. Blended learning in higher education allows more engagement with students in large classes, as well as more adaptable learning environments in terms of cost and administration. However, blended learning environments place greater emphasis on students' course engagement and self-regulated learning while studying online than when students are studying in a face-to-face learning environment (Gedik, Kiraz, & Ozden, 2012). That is, unlike in a face-to-face learning environment, students' success in blended learning environments may be more dependent on activities they engage in outside of the classroom (online) than on what happens in a classroom with an instructor. Therefore, to achieve satisfying learning outcomes, a blended learning environment requires that students take the first step toward learning, assess their needs, set learning goals, identify learning resources, manage time and environment, and employ effective learning strategies

(Tsai, Shen, & Tsai, 2011). That is, a blended learning environment requires students to be skilled in self-regulated learning.

Nonetheless, literature suggests that students' use of SRL strategies may vary as they progress through different tasks or learning situations. SRL abilities can improve in learning contexts that allow and promote control over the important factors of learning. Blended learning is recognized as one of the environments that enable students to manage and regulate their learning activities, hence improving SRL (Dettori & Persico, 2007). Although there has been little research comparing the use of SRL strategies in a blended and face-to-face learning environment, it has been shown that students enrolled in a blended learning environment use SRL strategies more frequently than students enrolled in a face-to-face environment. For instance, Setyaningrum (2019) conducted a quasi-experiment using a pre-test and post-test group design on 115 grade 10 mathematics students from two senior high schools to investigate the influence of blended learning on students' self-regulated learning. The experimental group was taught using a blended learning strategy, while the control group was taught using a traditional approach in which the teaching and learning process was handled entirely face-to-face. It was found that students who studied in a blended learning mode had a higher SRL score than those who only studied in a face-to-face mode. The flexibility of accessing learning materials and control of learning speed in the blended learning mode was indicated as a factor for the difference in SRL scores between the two groups.

The use of SRL strategies in a blended learning environment was also compared to the use of SRL strategies in an online learning environment. Using the MSLQ as a data collection instrument, Broadbent (2017) found that except for the strategies of peer learning and help seeking, which were reported to be used significantly more often by blended learning students, online learning students reported utilizing all SRL strategies more frequently than blended learning students. Critical thinking and rehearsal strategies were reportedly used moderately by both groups. There is little research that compares online learning students and their face-to-face counterparts; therefore, more research is needed to compare how online students and their face-to-face counterparts use SRL strategies to improve their academic performance. Broadbent (2017) also found that SRL strategies, such as elaboration, organization, metacognitive self-regulation, time management and effort regulation were correlated with good academic performance. Similarly, Zhu, Au, and Yates (2016) investigated the relationship between self-control, self-regulated learning, and learning outcomes in a blended course of Information and Communications Technology (ICT) in Education and found that students who reported higher levels of self-control and self-regulated learning had better learning outcomes. The findings of the study emphasised the significance of students' self-control and use of self-regulatory strategies in a blended learning environment. However, it was recommended that additional research into the design of blended learning is needed to encourage more use and implementation of SRL strategies by students (Setyaningrum, 2019).

Based on the findings of the studies, Setyaningrum (2019) and Broadbent (2017), it is possible to conclude that specific self-regulated learning strategies are associated with a type of learning environment, whether face-to-face, entirely online, or blended. Broadbent and Fuller-Tyszkiewicz (2018) explored this assumption by establishing different profiles of self-regulated learning and determining whether membership in a profile is related to a learning environment (blended versus wholly online). The study identified five distinct profiles of self-regulated learning using Latent profile analysis (LPA). LPA is a classification method that identifies distinct classes of individuals that respond to a set of continuous variables in comparable ways. The goal of LPA is to find the least number of unique groups of similar people that best represent the data patterns (Collins & Lanza, 2009). The five profiles identified were: (1) Minimal regulators, they had the lowest scores of all profiles, with low to moderate scores on all motivation variables and low scores on all self-regulated learning factors. (2) Restrained regulators, who, despite being higher than minimal regulators, have low to moderate self-regulated learning strategies and moderate motivation. (3) Anxious capable collaborators were identified by their high-test anxiety and moderate to high scores on all other strategies and motivations. (4) Calm, self-reliant, capable regulators were those that used peer or outside help and had the lowest test anxiety. Finally, there were (5) super regulators who outperformed the other profiles on most factors. LPA did not produce a profile consisting solely of online students in their study, nor did it produce any profiles consisting solely of blended learning students (Broadbent & Fuller-Tyszkiewicz, 2018). This suggests that the earlier assumption that certain self-regulated learning strategies may be associated with study mode is not always true, as there is heterogeneity in the approach to learning among online and blended learning students.

2.5 SRL AND ONLINE LEARNING

This section examines research into the relationship between self-regulated learning and online learning. Although the papers discussed in this section are not specifically related to online learning during a pandemic, they do provide a general understanding of how students conduct themselves and regulate their learning in an online learning environment.

Past research has indicated that self-regulated learning has a substantial impact on student success, particularly in online and blended courses (Wang, Shannon, & Ross, 2013). Students must be able to learn independently to be successful in online learning, which means they must oversee their own learning and decide when, where, and for how long they want to access learning materials within the time range of the activities of the modules in which they are enrolled (Harrell, 2008). Students who do not go the extra mile to accomplish tasks that will help them to meet their educational goals in an online learning environment, on the other hand, risk attrition because there are no instructors to push them, unlike in traditional face-to-face learning environments (Hart, 2012). Students must transition from being passive learners to being active learners to succeed in an online learning environment (Chumbley, Haynes, Hainline, & Sorensen, 2018). Traditional teaching via lectures is regarded as a passive learning environment (Smart, Witt, & Scott, 2012). The active learner model, on the other hand, assigns students the task of gaining knowledge through a

constructivist method in which the student uses prior knowledge to aid in the formation of new educational concepts (Prince & Felder, 2006).

As important as SRL is for good academic performance in online learning, it is well understood that students' levels of SRL differ and that distinct profiles of SRL behaviours exist across students (Broadbent & Fuller-Tyszkiewicz, 2018). Barnard-Brak, Paton, and Lan (2010) investigated if SRL profiles of students existed in an online learning environment and whether members of different profiles differed significantly in their academic achievement. The OSLQ was used to collect data and the study included 279 students enrolled in online degree programs at a public university in the Southwest United States. Five SRL profiles were discovered: minimal self-regulators, forethought-endorsing self-regulators, performance/reflection-endorsing self-regulators, competent self-regulators, and super self-regulators. The minimal self-regulators were students that endorsed the SRL strategies the least. Students who reported using goal setting and environment structuring more than other subscales were described as forethought-endorsing self-regulators because these tasks form part of the planning phase of SRL strategies. Performance/reflection-endorsing self-regulators strongly endorsed task strategies, time management, help seeking, and self-evaluation. These are commonly associated with the performance control and self-reflection phases in the development of SRL strategies. Competent self-regulators appeared to be moderately to strongly endorsing SRL strategies, but not to the same level as those who could be labelled super self-regulators. Super self-regulators highly endorsed SRL strategies across all subscales (Barnard-Brak, Paton, & Lan, 2010).

In terms of academic performance, super and competent self-regulators had the highest GPAs, and there was no statistically significant difference in GPA between the two groups. Therefore, while being a super self-regulator appears to be ideal, the results show that competent self-regulators perform just as well in terms of academic success. This is most likely because they are exploring and understanding their learning environment enough to do well. Minimal self-regulators along with forethought- and performance/reflection-endorsing self-regulators had the lowest GPAs and there were no statistically significant differences in GPA between the three groups. According to these findings, both minimal and disordered profiles of self-regulated learning are associated with similar, inferior academic results. It appears that disorder in self-regulated learning strategies is just as detrimental for a student as no or minimal self-regulation. Overall, this study discovered that being skilled in self-regulated learning is associated with good academic performance in the online learning environment investigated.

Chumbley, Haynes, Hainline, and Sorensen (2018) in a separate study asked secondary school students enrolled in an online agriculture course to rate their level of self-regulated learning. The OSLQ was utilized to collect data from 106 out of 146 students who took part in the course. Environment structuring was revealed to be the sub-scale where students scored the highest among the self-regulated learning constructs. It was assumed that because asynchronous online education had a less constrained schedule, students felt more in control of their studies. The statements relating to the task strategies construct had the lowest level

of agreement among the participants. This was attributed to the fact that secondary students, who are used to the traditional method of learning in a face-to-face learning environment, have not yet mastered the task strategies required in the self-directed environment of online learning. This was substantiated by the discovery of a significant relationship between past online learning experience and the students' overall self-regulated learning.

Broadbent and Poon (2015) conducted a meta-analysis to determine how students might use self-regulated learning strategies to attain academic success in an online setting in higher education institutions. Only studies that investigated how SRL strategies were used by students enrolled in an online or web-based course with an academic achievement outcome variable were included. Studies that included only face-to-face or blended learning environments were excluded. SRL strategies included in the meta-analysis were metacognition, time management, effort regulation, peer learning, elaboration, rehearsal, organisation, critical thinking, and help seeking. Academic achievement was found to be weakly correlated with metacognition, time management, effort regulation, and critical thinking. These findings suggested that in an online setting, students who make effective use of their time, are aware of their learning behavior, are critical in their content examination, and persevere in comprehending the learning material despite difficulties are more likely to get higher academic grades. The cognitive strategies of elaboration, rehearsal, and organization were discovered to be unrelated to online academic achievement. Rehearsal, for example, is regarded to be a surface-level strategy that does not generate rich learning. Elaboration, on the other hand, is considered a higher-level strategy that entails more in-depth information processing. While elaboration appears to be effective in a typical classroom setting, it was found to be less effective in an online setting in this meta-analysis. The findings suggest that when learning new content, online students should not devote time to elaboration, rehearsal, or organization, as these strategies may not necessarily enhance the likelihood of academic success. These findings could be the outcome of moving traditional teaching methods and materials to an online learning environment. Therefore, instructors should take advantage of the benefits of online environments, such as flexibility, while also carefully planning for the development of self-regulatory skills.

All in all the reviewed literature emphasises the positive relationship that exists between SRL and good academic performance in an online learning environment. However, it is noted that some learning strategies were found to be unrelated to online academic achievement.

2.6 ONLINE LEARNING AND COVID-19

Coronavirus disease (Covid-19) is a disease that is caused by a novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Viruses identical to SARS-CoV-2 caused diseases including the severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS) in 2002 and 2012, respectively. SARS-CoV-2, on the other hand, has a broader range than similar previously described viruses, which adds to the challenge of treating and managing Covid-19. Depending on the individual's immune

system, those infected with Covid-19 can be symptomatic or asymptomatic in the early stages of infection, according to medical diagnosis and research. Covid-19 was declared a pandemic by the World Health Organization (WHO) on March 11, 2020, based on the rate at which it was spreading and claiming human lives around the world.

Governments around the world, including the South African government, instituted lockdown in their various countries based on the severity of the pandemic to keep it from spreading. To flatten the curve and thereby control the spread of the Coronavirus, the South African government imposed a strict countrywide lockdown (Mahaye, 2020). According to Fowler et al. (2020), lockdown is effective in preventing the transmission of Covid-19, but it has a significant economic impact. During the lockdown, businesses were closed, jobs were suspended, and educational institutions were also closed. Educational institutions were forced to move to online platforms and initiate online learning. Hrastinski (2008) claims that for online learning to be effective and efficient, educators, organizations, and institutions must have a thorough understanding of the benefits and drawbacks of online learning. Hodges et al. (2020) distinguished well-planned online learning experiences from crisis-response courses provided online. Effective online learning entails carefully designed online teaching and learning grounded on research, and the assessment of the quality of online course design, teaching, and learning (Hodges, Moore, Lockee, Trust, & Bond, 2020). Due to the lack of a comprehensive design and development approach in the migration process, the contemporary online education experience during this pandemic was rejected as effective online education and instead labelled as emergency remote teaching (Bozkurt & Sharma, 2020; Hodges, Moore, Lockee, Trust, & Bond, 2020).

Some of the disadvantages associated with the sudden move to online learning include lack of access to fast, affordable, and dependable internet connections which hinders the process of online learning, particularly for people living in rural and marginalized regions (Dube, 2020). Zhong (2020) argued that another concern with online learning is a lack of adequate interaction with instructors, for example, concerns about any of the content of the online course are usually discussed with the relevant course instructor via e-mail, which usually requires a response time. Students who prefer to learn through social interaction would be uninterested in virtual classes because traditional classroom socialisation is another factor that is lacking in online learning (Britt, 2006). Students only communicate with their peers digitally and never meet in person and thus real-time sharing of ideas, knowledge, and information is limited in the online learning environment (Adnan & Anwar, 2020). However, it appears that the Covid-19 pandemic will continue for some time and as per the instructions of WHO, we now must adjust our daily activities with Covid-19, therefore educational institutions must develop relevant content, set up an effective delivery system, and provide digital literacy training to their current faculty to obtain improved learning outcomes.

2.7 SYNTHESIS

Self-regulated learning theory was unpacked as a theoretical framework for this study. The relationship between the use of SRL strategies and academic performance was examined, and it was shown that SRL skills are associated with good academic performance. Several studies revealed that learning strategies such as management of time and study environment, effort regulation, peer learning, and help seeking are associated with good performance (Barnard-Brak, Paton, & Lan, 2010; Broadbent, 2017; Broadbent & Poon, 2015; Miller, 2015; Zhu, Au, & Yates, 2016). The importance of students' self-control, use of self-regulatory strategies, and course participation was highlighted as important for students' success in a blended learning environment. SRL scores for blended learning students were found to be low when compared to students in a fully online learning environment. However, no specific learning strategies were shown to be more important to a particular mode of learning rather, there is heterogeneity in the use of SRL strategies in these learning environments. The use of SRL strategies in an online learning environment was also examined, and it was discovered that being skilled in self-regulated learning is associated with good academic performance, and a lack of SRL skills is detrimental to a student. Students who make effective use of their time, are aware of their learning behaviour, are critical in their content examination, and persevere in comprehending the learning material despite difficulties are more likely to achieve higher academic grades in an online setting (Barnard-Brak, Paton, & Lan, 2010; Broadbent & Poon, 2015).

Previous research has emphasized the importance of self-regulated learning for good academic performance in a face-to-face, blended, or online learning environment. The sudden and unexpected shift to online learning as a result of the pandemic necessitated that the students should be skilled in self-regulated learning in order to cope with the workload and achieve good academic outcomes in an unfamiliar environment not of their choosing. Past research has focused on the use of SRL strategies in online settings, but the use of SRL strategies in an online learning environment during a Covid-19 pandemic is novel; thus, the current study aims to explore and investigate the use of SRL strategies in an online learning environment during the Covid-19 pandemic. The study included only first-year chemistry students, with the goal of using the findings to improve first-year chemistry teaching and learning, as well as possibly guiding the design of interventions to academically benefit first-year chemistry students in the future and direct them toward becoming better self-regulators of their own learning.

CHAPTER 3: METHODOLOGY AND METHODS

This section begins with a definition of methodology and continues to give the chosen methodological approach followed and the justification of the choice. Next, the chosen research design and data collection methods are presented. After sampling, data collection instruments and means of data analysis for the study are discussed, the section concludes with some limitations and ethical considerations that may be associated with the study.

3.1 RESEARCH METHODOLOGY AND DESIGN

Methodology can be defined as the strategy, course of action, or process that drives the selection and application of methods, as well as the connection between the selection and application of methods and the desired outcomes. As a result, methodology encompasses not just the data collection and analysis methods used, but also the theoretical rationale for their use based on the types of information they can produce (Case & Light, 2011). The researcher should determine which methodology can lead him or her to the most accurate results that adequately address the research questions quickly, easily, and efficiently (Devetak, Glažar, & Vogrinc, 2010).

The current study sought to investigate the use of self-regulated learning strategies by first-year chemistry students in an online learning environment during the Covid-19 pandemic. The use of learning strategies in this setting is unique; therefore, a case study methodological approach was chosen for this study. A case study is defined an in-depth investigation or evaluation of single or multiple events, an individual, a group, or a society (Case & Light, 2011). A case study examines a single case or cases from numerous angles; it studies the complexity and uniqueness of the subject and develops a thorough knowledge of it (Jónasdóttir, Hand, Misener, & Polgar, 2018). The case study methodology is often criticized for its limitation in terms of generalisability of results (Case & Light, 2011). However, according to Flyvbjerg (2001), the concrete, context-dependent quality of the knowledge that case studies uncover is the strength of this methodology. Taking all of this into account, a case study appeared to be the most appropriate method for answering research questions about the use of learning strategies in this study. In the present study, the case study methodology allowed for the collection of data that was rich and detailed on how students behaved academically during the unique circumstances of online learning due to the pandemic. It also allowed the researcher the freedom to use various methods to get the in-depth information needed.

In terms of overall research design, a mixed methods design was chosen for this study. Mixed methods design was chosen because it incorporates both quantitative and qualitative methods in a single study and enables their strengths to complement each other (Tashakkori & Teddlie, 2002). However, it is essential that that the two mixed methods are compatible in terms of data collection, data analysis and interpretation of results. The explanatory sequential approach was chosen for the study where the quantitative phase was followed by the qualitative phase, to explain, enhance, and enrich the quantitative findings (Creswell & Clark, 2017). This mixed-methods approach increases confidence in results by providing more evidence

while compensating for potential flaws in using a single approach (Tashakkori & Creswell, 2008). **Figure 3.1** below shows a diagrammatic representation of Creswell's explanatory sequential mixed methods design.

Figure 3.1: Explanatory sequential mixed methods design (Creswell & Clark, 2017)

3.1.1 Phase 1: Quantitative methods

The first phase of this study involved gathering quantitative data through a questionnaire. The questionnaire was a hybrid of the learning strategies section of the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1993) and a 24 item Online Self-regulated Learning Questionnaire (OSLQ) (Barnard, Lan, To, Paton, & Lai, 2009) (see **section 3.3.2** for instrument adaptation procedure). Students were asked to score a list of pre-identified activities or items on a Likert scale of 1 to 4, with 1 representing "*not at all true of me*". 2 representing "*seldom true of me*", 3 representing "*mostly true of me*" and 4 representing "*very true of me*". Originally, the MSLQ had seven response categories, while the OSLQ had five. The number of response categories in the final questionnaire of our study was reduced to four to lower cognitive load. If there are too many response options available, participants may have difficulty differentiating between similar response levels, causing them to choose a response option arbitrarily (Revilla, Saris, & Krosnick, 2014). A neutral option was not included in this study to avoid distortions commonly associated with the middle category of Likert scales (Nadler, Weston, & Voyles, 2015), as well as because it was determined in a pilot study that it has a negative influence on the reliability of the OSLQ (see pilot study results in Appendix B). The scores were used as an indication of the degree to which students utilised the learning strategies.

3.1.2 Phase 2: Qualitative methods

Qualitative data were collected during the second phase of the study. The data were collected through a semi-structured open-ended follow-up survey with a small group of students. This was done to get more clarity and in-depth information on certain questionnaire responses that required more investigation before clear conclusions could be drawn.

3.2 SAMPLING DESIGN

A sampling design is a pre-determined plan for obtaining a sample from a given population that is defined before any data is collected (Kothari, 2004, p. 14). A non-probability sampling design known as convenience sampling was used in phase 1 of this study. Convenience sampling is when the members of a population are included in the sample based on the ease of access and convenience, members of the target population must meet certain practical criteria, such as easy accessibility, geographical proximity, availability at a given time, or the willingness to participate (Kothari, 2004, p. 15; Etikan, Musa, & Alkassim, 2016). Since the data collection was dependent on the students' willingness to participate, that is, the data was collected from

students who were willing and able to participate at the time the survey was conducted, the sampling design was thus categorized as convenience sampling.

Students enrolled in a BSc general chemistry module coded CMY 127 were asked to participate in the study. Students were given access to the questionnaire through the learning management platform, Blackboard, also known as clickUP at the University of Pretoria, CMY 127 was selected because it is a first-year chemistry module offered in the second semester. It was assumed that by the second semester, first-year students would have developed their learning strategies for their new learning environment, that is, the university environment following a semester of transition. Furthermore, due to the pandemic and an unexpected shift to online learning, it was assumed that by the second semester, students would have adopted new learning strategies that fit the new learning context of online learning during the Covid-19 pandemic. As a result, learning strategies associated with success in this context would be a true indicator of the learning strategies used by students.

For the qualitative part of the study (phase 2), nonprobability purposive sampling was used to select participants. Purposive sampling is the deliberate selection of a participant based on the attributes the individual possesses. It is a non-random technique that does not require any underlying hypotheses or a predetermined quantity of participants. The researcher determines what needs to be known and then sets out to identify people who can and are willing to supply the information through their knowledge or experience (Bernard, 2017). This entails identifying and selecting individuals or groups of individuals who are knowledgeable about a topic of interest (Creswell & Clark, 2017). Bernard (2017) also emphasizes the significance of availability and willingness to participate, as well as the ability to share experiences and viewpoints in an eloquent, expressive, and introspective manner. This sample was drawn from students who had already taken part in phase 1 of the study. Students were purposefully selected according to how they responded to the items of certain subscales. Therefore, the decision on the selection of participants was dependent on the results of phase 1 of the study.

3.3 RESEARCH TOOLS AND TECHNIQUES

This section describes the instruments used to collect data in both phases 1 and 2 of the study. The process for adapting the instrument for quantitative data collecting is also described. Data analysis techniques are also presented.

3.3.1 Phase 1: Quantitative data collection

In this study a combination of two questionnaires: Motivated Strategies for Learning Questionnaire (MSLQ) and Online Self-regulated Learning Questionnaire (OSLQ) was used to collect data in the quantitative phase of the study. As mentioned previously in the literature review (section 2.7), the MSLQ is divided into two sections: a motivational section and a section on learning strategies. However, the motivation section of the MSLQ was not included in our study for two reasons: (i) when Rasch analysis was performed previously in a related study by Kritzinger *et al.* (2018), the items on the motivation section did not have appropriate

statistical characteristics, and (ii) to avoid respondent fatigue due to the length of the questionnaire. Respondent fatigue transpires as interest and enthusiasm of questionnaire participants drops as they progress through the questionnaire. Respondents who are tired are more likely to answer, "don't know", or respond in a "straight-line" manner (choosing answers down the same column on a page) or abandon the questionnaire altogether (Lavrakas, 2008). Thus, only the learning strategies section of the MSLQ was used for data collection.

The learning strategies component of the MSLQ comprises of 50 items and is divided into three types of strategies: cognitive, resource management, and metacognitive strategies. Cognitive strategies consist of four subscales: (1) rehearsal, (2) elaboration, (3) organisation and (4) critical thinking. Rehearsal involves repeating and reciting information to activate the working memory. Elaboration involves paraphrasing, summarizing, and taking notes to help store knowledge in the long-term memory and construct internal connections. Organization encompasses strategies for selecting and connecting relevant information and critical thinking refers to the ability of students to apply prior knowledge, solve problems, make decisions, analyse, and review knowledge. Metacognitive strategies consist of one large subscale: (1) metacognitive self-regulation which refers to the awareness, knowledge, and control of cognition. Lastly, resource management strategies consist of four subscales: (1) time management, (2) effort regulation, (3) peer learning and (4) help seeking. Time management refers to how a student manages his or her study time by arranging, organizing, and handling it. Managing the study environment refers to how a student develops an environment that is appropriate and fits his or her personal learning style. Effort regulation refers to the management of effort and attention, as well as a commitment to the tasks and goals. Peer learning is when students learn with and from one another. Lastly, help seeking refers to how a student utilizes peer and instructor support (Pintrich, 1991).

Due to the pandemic, the first-year chemistry course on which this study is based went fully online and while the MSLQ was created before the emergence of online or blended learning, its modular system allows for the integration of a component to probe for the use of SRL strategies specific to the online learning environment (Soemantri, Mccoll, & Dodds, 2018), and thus for this purpose items from the OSLQ were integrated. The OSLQ is a 24-item scale with a 5-point Likert response format, with values varying from strongly agree (5) to strongly disagree (1). The OSLQ consists of six subscale constructs including: environment structuring; goal setting; time management; help seeking; task strategies; and self-evaluation (Barnard, Lan, To, Paton, & Lai, 2009).

In this paragraph the researcher attempts to give descriptions of the OSLQ subscales based on the items that make up the subscales. Environment structuring can be described as the student's ability to manage their study environment and keep it organized, quiet, and distraction-free. Goal setting required students to develop an action plan to motivate and guide them in achieving their module goals. Time management was concerned with effectively managing study time, such as by scheduling and planning times to complete

schoolwork. Help-seeking can be described as seeking assistance from others when encountering content that is difficult to understand. Students who exhibit help-seeking behaviour seek clarification from their peers and instructors to ensure that they are on the right track. Task strategies entailed going above and beyond the formal course requirements to benefit from learning material and learning opportunities. Finally, self-evaluation assesses students' ability to evaluate their academic activities to improve. For the purposes of this study, one item, "*I prepare my questions before joining in discussion forum*" from task strategies was split into two items "*I use the discussion board to ask questions I have about the course content*" and "*I prepare my questions before joining a virtual class discussion (Blackboard Live virtual lecture)*" to make it more appropriate to the structure and design of the chemistry module under investigation. This brought the total number of OSLQ items to 25.

3.3.2 Phase 1: Instrument adaptation procedure

When the two questionnaires (MSLQ and OSLQ) were compared, it was deduced that, although each questionnaire has its unique set of subscales, there are several subscales that overlap. If the learning strategies section of the MSLQ and the entire OSLQ were combined and used as they were, the result would be a lengthy questionnaire that could lead to respondent fatigue. Therefore, the overlapping subscales between the questionnaires were carefully considered to help determine which subscales should be used in the final questionnaire for the main study. The goal was to create a shorter questionnaire that would assess self-regulated learning in an online learning environment. Rehearsal, elaboration, organisation, critical thinking, effort regulation and peer learning were found to be unique to the MSLQ. Similarly, task strategies subscale of the OSLQ was unique to the questionnaire. Although goal setting may appear in both the MSLQ (motivation section) and the OSLQ, it was deemed unique to the OSLQ as the motivation section of the MSLQ was not used in this study. The MSLQ and OSLQ had overlapping subscales in time and environment management, help seeking, metacognitive self-regulation and self-evaluation.

This section compares the overlapping subscales, sets out some of their properties, and demonstrates why certain subscales were included in the final questionnaire of the main study. When choosing the subscales to include in the final questionnaire, three factors were considered: Cronbach's alpha values, item count, and whether the subscale was tailored for online learning. Cronbach's alpha values for the MSLQ when it was developed and for the OSLQ when it was developed, as well as from the pilot study in the current research project, are shown in **table 3.1** and **table 3.2** below.

Table 3.1: Cronbach's alpha values for the learning strategies section of the MSLQ (Pintrich, 1991).

Subscale	Cronbach's alpha
Rehearsal (4)	0.69
Elaboration (6)	0.76
Organisation (4)	0.64
Critical thinking (5)	0.80
Metacognitive self-regulation (12)	0.79
Time and study environment (8)	0.76
Effort regulation (4)	0.69
Peer learning (3)	0.76
Help seeking (4)	0.52

Table 3.2: Cronbach's alpha values for OSLQ subscales (Barnard *et al*. 2009) and from the pilot study.

Subscale	Cronbach's alpha (2009)	Cronbach's alpha (pilot study)
Goal setting (5)	0.95	0.73
Task strategies (5)	0.93	0.41
Environment structuring (4)	0.92	0.64
Time management (3)	0.87	0.56
Self-evaluation (4)	0.94	0.40
Help seeking (4)	0.96	0.54

The MSLQ subscale of time and study environment was discovered to overlap with two OSLQ subscales, namely time management and environment structuring. Metacognitive self-regulation (MSR) from the MSLQ overlapped with self-evaluation of the OSLQ. Help seeking from the MSLQ overlapped with help seeking of the OSLQ. **Table 3.3** shows the Cronbach's alpha values and number of items for these subscales from both questionnaires, as well as the subscales chosen to be included in the final questionnaire and the justification thereof. In **table 3.3**, the Cronbach's alpha values for the two subscales of time management and environment structuring from the OSLQ were combined to correspond to the one subscale of time and study environment from the MSLQ.

Table 3.3: Selection and justification of subscales included in the final questionnaire.

Overlapping subscales	Cronbach's alpha			Number of items			Chosen subscales	Justification
	MSLQ	OSLQ (2009)	Pilot study	MSLQ	OSLQ (2009)	Pilot study		
Time and study environment	0.76	Average = 0.90	Average = 0.60	8	Total = 7	Total = 7	OSLQ subscales were used	The subscales showed better reliability on the OSLQ and average reliability of 0.60 from the pilot study with a small sample indicated a potential for good reliability in a bigger sample. Following an inspection of the wording of items, it was apparent that most of the items in the two questionnaires were worded similarly. Since the length of the questionnaire was the primary concern, using the OSLQ subscales appeared to be a better choice. In addition, items of the OSLQ were developed especially for online learning.
Metacognitive self-regulation/ self-evaluation	0.79	0.94	0.40	12	4	4	MSLQ subscale was used	Metacognitive self-regulatory activities are categorized into three parts: planning, monitoring, and regulating. After evaluating the items on self-evaluation on the OSLQ, it was established that the subscale only assessed the monitoring component of metacognitive self-regulation. Since the items on the self-evaluation were similar in wording to those on the MSR of the MSLQ, one can infer that self-evaluation of the OSLQ is included in the MSR of the MSLQ. Although the MSR subscale seemed to be assessing three processes in one subscale, adequate reliability of 0.79 was shown in MSLQ manual. Lastly, self-evaluation of the OSLQ showed poor reliability in the pilot study. Therefore, MSR from MSLQ was chosen.
Help seeking	0.52	0.96	0.54	4	4	4	OSLQ subscale was used	The two subscales have the same number of items and are worded similarly, but the OSLQ demonstrated greater and more satisfactory reliability than the MSLQ. Since the goal was to build a questionnaire that had questions regarding online learning, it seemed appropriate to select a subscale that was developed to assess help seeking in an online learning environment.

The final questionnaire had a total of 59 items. However, two subscales (peer learning and time management) had only three items and having fewer items makes it difficult to make inferences. For each subscale (peer learning and time management), an additional item was added. For peer learning, item "*I do not have anyone with whom I can discuss to material/content that I am learning in this course." (Reverse coded)*" was added to probe the severity of the issue of a lack of peer learning opportunities. Furthermore, for time management, item "*I attend all my lectures for this course*" was added to probe how often students attend virtual synchronous lectures in the online learning environment. The addition of these two items took the total number of items of the final questionnaire to 61.

It was also noted that the wording of items in the final questionnaire was not explicit and would cause confusion among our students. As a result, clarifying words were introduced in brackets and some items were reworded to make them more suitable for the colloquial language of the targeted group; for example, an item from help seeking was originally "*I share my problems with my classmates online so we know what we are struggling with and how to solve our problems*" and was changed to "*I share my problems with my classmates online (WhatsApp, ClickUP, Facebook, etc.), so we know what we are struggling with and how to solve our problems*". When rewording the items, the researchers took care not to alter the meaning of the items. The final questionnaire is given in Appendix A.

3.3.3 Phase 1: Quantitative data analysis

The learning management system – Blackboard was used as a platform where quantitative data was collected. The Statistical Package for the Social Sciences (SPSS) and Rasch Unidimensional Measurement Models (RUMM) were utilized to conduct the statistical analysis. Survey data and student grades recorded in Blackboard were downloaded and transferred to Excel, SPSS, and RUMM programs.

Preliminary statistical analysis was carried out using the IBM SPSS Statistics for Windows, Version 27.0. The sample was divided into different subgroups based on academic performance. Descriptive and inferential statistical analysis were then performed to determine learning strategies that were associated with success through an examination of the use of learning strategies by these subgroups. This was accomplished using statistical tests such as independent t-tests and one-way analysis of variance (ANOVA). Following the ANOVA, a Tukey post hoc test was performed. An ANOVA test tells us whether the results are statistically significant in general, but it does not tell us where the differences are. Following a significant ANOVA, a Tukey's HSD ("honest significant difference") was used to determine which individual group means differed from one another. All possible pairs of means are compared in this test (Cohen, Manion, & Morrison, 2017). Effect sizes were calculated alongside independent t-tests and ANOVA to provide context for the practical significance of the difference in use of the learning strategies. Cohen's d was the effect size test used to compare two group means (independent t-tests), and η^2 was the test used to compare three group means (ANOVA) (Khalilzadeh & Tasci, 2017). Chi-square automatic interaction detection (CHAID) analysis was

also used to determine which demographics best predicted academic performance. Thereafter, a Rasch analysis was performed to analyse the overall instrument performance and transform the collected raw data into measurement data from which inferences could be made, that is, validity and reliability of the data collection instrument was established. This was done using the RUMM 2030 programme with the help of a research team member knowledgeable in Rasch analysis.

3.3.4 Phase 2: Qualitative data collection

Follow-up open-ended questions were sent to the students through email for the qualitative part of the study. The questions were intended to extract additional information about specific learning strategies that were discovered to be underutilized during quantitative data analysis to determine how much the Covid-19 pandemic influenced the use of those learning strategies. To optimally enrich the data obtained from the quantitative part of the study, students were encouraged to provide as much detail as possible on the questions presented to them. Appendix A has a list of follow-up questions emailed to the students.

3.3.5 Phase 2: Qualitative data analysis

Qualitative data analysis can be approached in a variety of ways. Some researchers quantify qualitative data through content analysis so that it can be statistically analysed. In this case, researchers want to see qualitative data aggregated in such a way that statistical analysis can be performed to produce the results (Cassell & Bishop, 2019). Thematic analysis is another popular method of analysing qualitative data. Thematic analysis is a method for identifying, assessing, organizing, describing, and reporting themes identified within a data set. These themes can then be combined to form a codebook or template, allowing for a more structured approach to data interpretation (Braun & Clarke, 2006). Because the goal of collecting qualitative data was to obtain detailed information about the poor use of specific learning strategies rather than to quantify the use of these learning strategies, thematic analysis was conducted as a form of analysis for the qualitative data in this study.

There are two approaches in which thematic analysis can be conducted: the inductive approach and the deductive approach (Azungah, 2018). Inductive approach analyses data with little or no predefined theory, structure, or framework, and derives the structure of analysis from the data itself. The primary goal of the inductive approach is to enable research findings to emerge from the common, predominant, or significant themes in the raw data without being constrained by formal methodologies. (Burnard, Gill, Stewart, Treasure, & Chadwick, 2008). By contrast, deductive approach employs an organizing framework comprised of themes for the coding process. The framework, also known as a start list, is used in the analysis to anticipate the presence of certain basic concepts in the data. The deductive approach is often associated with the disadvantage that key themes are frequently clouded, reframed, or left invisible because of preconceived notions in the data collection and data analysis procedures (Burnard, Gill, Stewart, Treasure, & Chadwick, 2008). However, deductive analysis has several advantages, such as the ability to explain causal relationships

between concepts and variables, the ability to quantify concepts, and the ability to generalize research findings to some level (Azungah, 2018).

Thematic analysis was performed using an inductive approach for this study since the researcher sought to derive the findings exclusively from the perspectives of the participants. Furthermore, the researcher noted that, while the follow-up questions may have influenced the conclusions, the findings come straight from the study of raw data, not from prior expectations or models. The analysis in this study involved coding, categorisation and eventually development of themes. A code is usually a word or a brief phrase that representatively gives a summative, notable, essence-capturing, and/or evocative attribute to a segment of language-based or visual data (Saldaña, 2021). Coding enables the researcher to simplify and focus on specific data characteristics. The procedure followed for the analysis is illustrated in the schematic that follows:

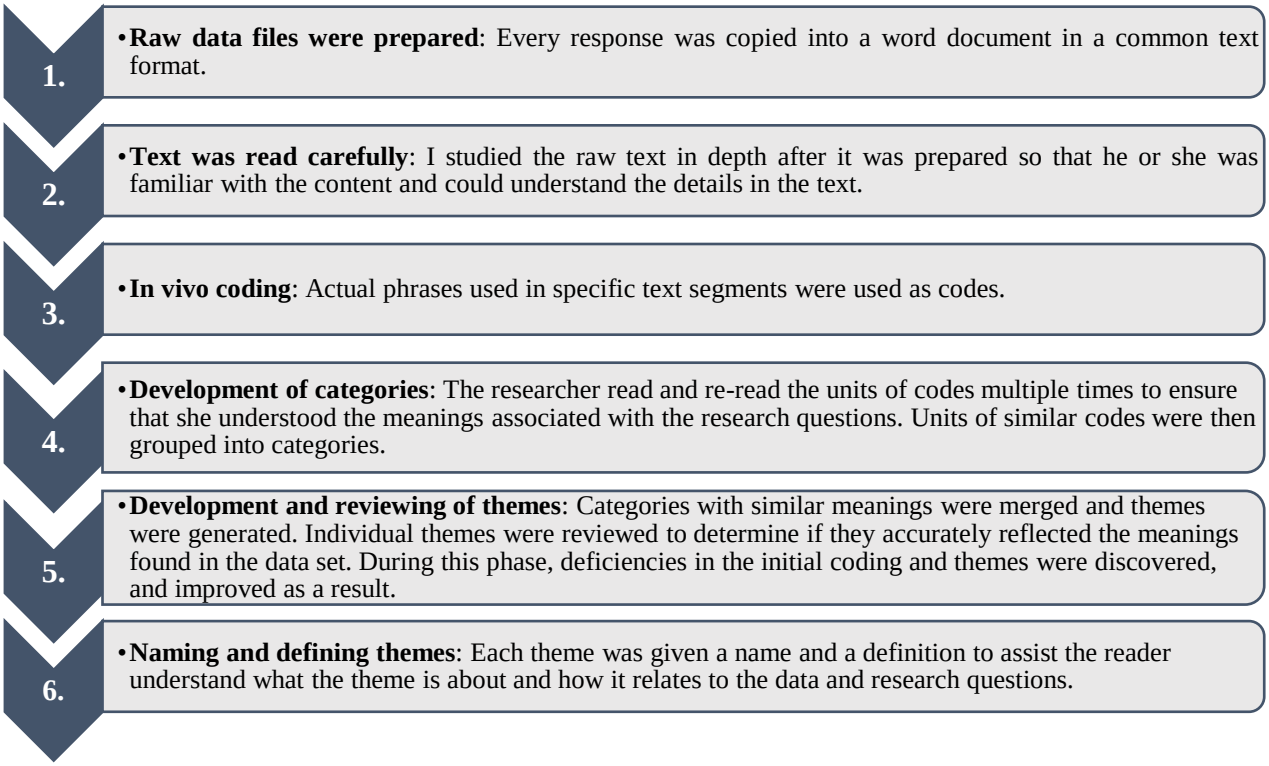

Figure 3.2: Thematic analysis procedure followed in the study.

Validity of qualitative results

Validity in qualitative analysis is defined as the degree to which the results accurately reflect the realities of the social phenomenon and are credible to the participants (Schwandt, 1997). When determining validity in this study, it was assumed that validity relates to the inferences generated from the data rather than the data itself. We approach the validity of qualitative results through different viewpoints or lenses. There is the 'lens of the researcher' and then there is the 'lens of study participants'. With the 'lens of a researcher', researchers determine whether the data is saturated enough to produce good themes or categories, and how

the data analysis matures into a persuasive narrative. Researchers repeatedly examine their data to determine if the constructs, categories, explanations, and interpretations are still valid using this lens. Whereas through the 'lens of the study participants' it is assumed that reality is socially constructed and is what the study participants understand it to be. Participants are actively involved in determining whether the interpretations accurately represent them (Creswell & Miller, 2000).

For this study, both the 'lens of a researcher' and 'lens of the study participants' were used as viewpoints to validate the results. To establish validity from the researcher's perspective, a research team member and I independently coded the raw data and categorised the codes, then compared them to determine whether there were any differences in the coding and came to an agreement. Students who showed willingness to provide additional information on the follow-up survey were asked to evaluate their individual analysed responses to determine if the researcher's main ideas were the main ideas they wished to convey.

3.4 ETHICAL CONSIDERATIONS

Ethical clearance for this study was granted by the Ethics Committee of the Faculty of Natural and Agricultural Sciences at the University of Pretoria (NAS075/2020). The primary goal of this study was to investigate learning strategies reported by students and identify those associated with success; thus, students were the primary data sources. Students' consent was obtained by ticking a box at the beginning of the electronic survey after an explanation of the purpose of the study, the procedures to be followed, measures to protect respondents' identities, and the opportunity to opt out.

The main ethical consideration with respect to data management for this project was protecting the identity of the student. Student data collected through Blackboard (students' questionnaire responses) came with the student identifiers. These identifiers will be removed after the data has been processed and before it is stored. Since our class sizes are large (>1000), once the identifiers have been removed, it will not be possible to trace individual results to a particular student. Note that the nature of the project meant that we were looking for broad trends and not focussing on individual students. For the students that participated in the follow-up survey, their identities were kept confidential and when the results were reported the students were assigned pseudonyms (for example Sofia or Peter (not their real names))

All intellectual property resides with the University of Pretoria, but the results are intended for public benefit and not commercial exploitation. The discoveries of this study will not only be shared within the Department of Chemistry at the University of Pretoria but will be presented at conferences and published if conceivable.

3.5 SYNTHESIS

For this study, a case study methodology was chosen. Mixed methods were used to address the research questions. To provide information about the use of learning strategies, participants were asked to complete a questionnaire in the quantitative part of the study and a follow-up survey with open-ended questions in the qualitative part of the study. The sample of the study was drawn from a population of first-year chemistry

students. The raw data provided by the students was subjected to statistical and thematic analyses to extract information about the use of learning strategies.

CHAPTER 4: PRELIMINARY RESULTS

This chapter presents the preliminary findings of the statistical analysis performed in SPSS in which the reported use of learning strategies was examined in relation to various sample characteristics. The chapter begins by describing the sample before moving on to describe how the participants performed on the exam based on their various demographics. Following that, the reported frequency of use of the learning strategies and the findings on the learning strategies associated with good performance are presented. Correlations between the learning strategies and exam performance are also provided. The chapter concludes with a discussion of the results.

4.1 OVERVIEW OF STATISTICAL ANALYSIS IN SPSS

As previously stated in the data analysis section, IBM SPSS Statistics for Windows, Version 27.0 was used to perform statistical analysis to explore differences in the reported use of learning strategies between subgroups of students divided by academic achievement and do correlations as well as performing CHAID analysis. This was done to identify the learning strategies associated with success. In this chapter the sample demographics (gender and home language) are described first, and the overall exam performance of the sample and the population is given. CHAID analysis was also performed to determine which independent variables were the best predictors of good academic performance in a final exam. The CHAID analysis results were used to categorize the sample into three performance subgroups according to their prospects of success in the course: At-risk (AR), Murky Middle (MM), and Likely to Pass (LTP). We defined at-risk students as those who were most likely to perform poorly or fail the exam, the murky middle students as those whose prospects of success are mixed, and finally likely to pass students as those who were most likely to perform well and pass the exam. The results on the overall reported use of the learning strategies by the whole sample are given to identify learning strategies that were reported to be used more and those that were reported to be used less by the students.

To identify learning strategies associated with success, two sets of the sample subgroups were considered: (i) the exam-pass and exam-fail, and (ii) performance subgroups (AR, MM & LTP). T-tests and ANOVA were employed to determine if there were any statistically significant differences in the reported use of learning strategies between the different subgroups. Correlations between exam performance and scores on the learning strategies were also established to aid the discussion of the findings acquired from the sample divisions.

4.2 DEMOGRAPHICS AND EXAM PERFORMANCE

The demographics of the sample are shown in **Table 4.1**. The sample size of the study was 430 with 422 complete questionnaires and 8 questionnaires with missing responses. As can be seen by the similar percentages of different demographics between the sample and the population, the sample was a good representation of the study population of 1370. Both the sample and the population had more females than males, and most of the students did not speak English as their home language.

Table 4.1: Demographic characteristics of the sample compared to the population.

Characteristics	Categories	*n* (out of 430)	N (out of 1370)
Gender	Female	312 (73%)	932 (68%)
	Male	118 (27%)	438 (32%)
Home language	English	150 (35%)	493 (36%)
	Non-English	278 (65%)	877 (64%)
Examination performance	Fail	252 (59%)	795 (58%)
	Pass	134 (31%)	397 (29%)
	Did not write	44 (10%)	178 (13%)

In terms of exam performance, only 31% of the sample passed the exam, which is close to the study population, where only 29% of students passed the exam. The lowest mark obtained on the exam from the sample was 8%, the highest mark obtained was 95%, and the group mean was 44.45%. **Figure 4.1** depicts the frequency distribution of the exam marks for the sample. The frequency distribution is slightly skewed to the right, indicating that the mean of the marks obtained by the students in this study was lower than the median, indicating that the students performed poorly on the exam overall.

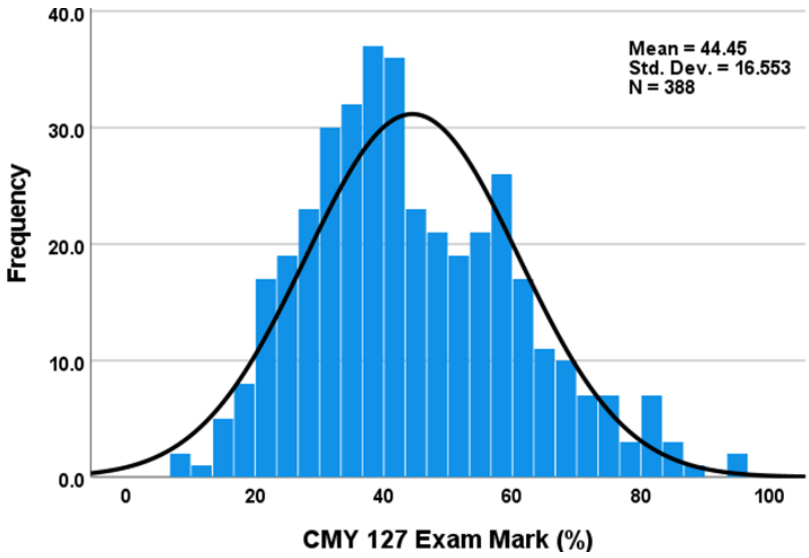

Figure 4.1: Frequency distribution of CMY 127 exam marks

Categorisation of students: CHAID analysis

The sample for this study was divided into three groups based on how students were expected to perform on the exam. The groups were ‘at risk’ (AR), ‘murky middle’ (MM) and ‘likely to pass’ (LTP). At risk students were those who were most likely to perform poorly or fail the exam, the murky middle students were those who were on the edge of failing or passing the exam, and finally likely to pass students were those who were most likely to perform well and pass the exam. This division was necessary as it allowed for a comparison between the reported use of learning strategies in terms of prospects of success in the exam and actual exam performance.

CHAID analysis was performed to divide the sample into AR. MM and LTP. The CHAID model generates a tree diagram by determining the most important predictor factors linked to the outcome variable and then splitting the first predictor variable into subgroups that are significantly different from one another. The model moves on to the rest of the predictor variables after the first split is formed depending on a chi-square test to find the optimum split at each step. This process is repeated until no substantial contributions are left (Nisbet, Elder, & Miner, 2009). The predictor variables were a combination of demographic data and prior to the examination academic performance data. Examination marks were the outcome variable. Examination marks were divided into two categories: pass (1) versus fail (0). For demographic data, school quintiles were transformed into five categories (quintile 1 to 5), home language was transformed into two categories (English versus non-English speakers) and gender was transformed into two categories (male versus female). School performance data that is, grade 12 mathematics and physical sciences marks were left as continuous data and not changed, results of previous semesters' chemistry exams, as well as the results of the three semester tests for CMY 127 were also kept as continuous data. The results of the CHAID analysis are shown in **figure 4.2**. It is evident from **figure 4.2** that the demographical data that were included as input variables were not linked to performance. Instead, the academic performance data prior to examination were found to be the strong predictors of performance in the exam.

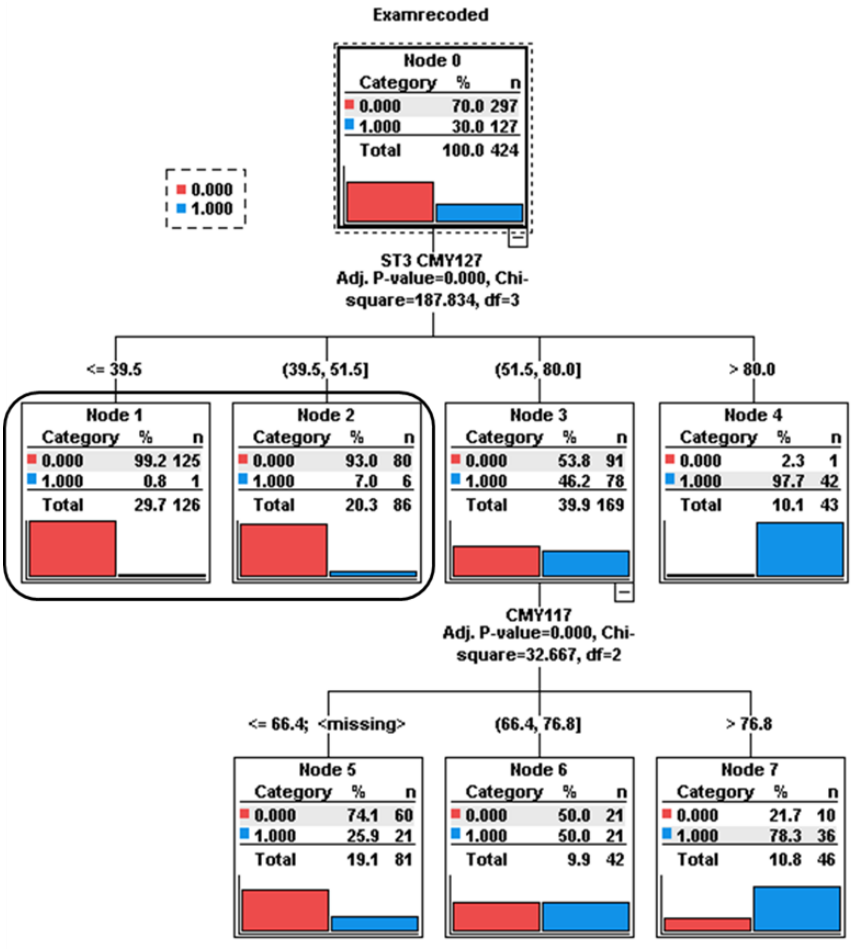

Figure 4.2: CHAID analysis with examination as the outcome variable.

Students who passed the exam are shown by blue bars, whereas students who failed are represented by red bars, with the height of the bars denoting fractions of the subgroup. The total number of cases and their percentage of the test sample are reported in each box. Based on the results of semester test 3 (chi-square = 151.34, df = 3, p = 0.000), the sample was divided into four nodes (**Figure 4.2**). Upon closer investigation, however, it became evident that nodes 1 and 2 indicate groupings of students who have a low likelihood of succeeding: 0.8% and 7%, respectively. As a result, these two nodes can be merged to produce three separate subgroups of size: 212, 169, and 43 students. As a result, students with a semester test 3 score of less than 52% were classified as at risk because they had a >95% chance of failing the module. Students who had a mark between 52 and 80% were classified as MM because they had an approximately 50% chance of failing or passing, while those who had a mark higher than 80% were classified as LTP.

4.3 OVERALL REPORTED USE OF LEARNING STRATEGIES (*n* = 430)

This section displays the mean scores of the overall reported use of the learning strategies for the entire sample. The goal was to determine which learning strategies were reported to be used more frequently and which were reported to be used less frequently by the whole sample. Total scores of responses to individual learning strategies were calculated for each participant using the following method: if for example, a student responded to PL1 with 2 (seldom true of me), PL2 with 1 (not at all true of me), PL3 with 4 (very true of me), and PL4 with 3 (mostly true of me), then the total score for peer learning for that participant becomes a 7. This means that for four-item learning strategies, the minimum total score must be 4 and the maximum total score must be 16, for five-item learning strategies, the minimum total score must be 5 and the maximum total score must be 20, and for six-item learning strategies, the minimum total score must be 6 and the maximum total score must be 24. The minimum and maximum total scores for metacognitive self-regulation with 12 items must be 12 and 48, respectively. Calculations were performed on the entire sample for all learning strategies.

Table 4.2 shows the means of the total scores of the individual learning strategies. To allow fair comparisons of the reported use of the learning strategies, the mean scores were normalised and converted to a total score of 4 as they were obtained from total scores of different scales (last column of **Table 4.2**). Each mean value was divided by the number of items in the subscale. For example, the mean score for peer learning was 7.98, therefore, 7.98/4 gives 2.00. High normalised mean scores indicate that learning strategies were the most reported to be used by the students and vice versa.

Table 4.2: Self-Regulated Learning Scores for the whole sample

Subscale	No of items	Mean of total scores (*n* = 430)	Normalised mean
Peer learning	4	7.98	**2.00**
Help seeking	4	8.38	**2.10**
Task strategies	5	11.07	**2.21**
Critical thinking	5	11.49	2.30
Time management	4	9.76	2.44
Rehearsal	4	10.84	2.71
Organisation	4	11.19	2.80
Metacognitive self-regulation	12	33.58	2.80
Goal setting	5	14.31	2.86
Elaboration	6	17.71	**2.95**
Effort regulation	4	12.47	**3.12**
Environment structuring	4	12.96	**3.25**

Table 4.2 shows that students reported using the learning strategies of environment structuring, effort regulation, and elaboration the most meaning that the items that constitute these learning strategies were reported to be used by most of the students. The opposite is true for critical thinking, task strategies, help seeking, and peer learning, where the learning strategies were reported to be used the least. Most students appear to have responded poorly to the items that constitute these learning strategies.

4.4 LEARNING STRATEGIES ASSOCIATED WITH SUCCESS

Inferential statistical analysis was performed to identify learning strategies associated with success in CMY 127 in 2020. For the purposes of this study, learning strategies associated with success were defined as those reported to be used more frequently by students who passed the exam. Correlations between learning strategies and exam performance were also used to support the arguments of learning strategies associated with success. To substantiate the findings, the reported use of the learning strategies according to the performance subgroups (AR, MM and LTP) was investigated.

Reported use of learning strategies in terms of exam performance

Students that passed the exam scored higher on elaboration, metacognitive self-regulation, effort regulation, goal setting, tasks strategies, time management and environment structuring. The results are shown in **table** C1 in appendix C. **Table 4.3** displays the results of independent t-tests for learning strategies that revealed statistically significant differences between students who passed and students who failed the exam, as well as the effect sizes. Cohen's *d* metric was used to calculate the effect sizes. For this study we use cut-off points and interpretations of effect size measures recommended by Khalilzadeh and Tasci (2017). Effect sizes less than 0.5 are considered small, effect sizes between 0.5 and 0.8 are considered medium, and effect sizes of 0.8 and above are considered large (Khalilzadeh & Tasci, 2017).

It was found that out of all learning strategies reportedly used more by students who passed the exam, only effort regulation, goal setting and time management had statistically significant differences and these are

highlighted in **blue**. Although all three learning strategies had small effect sizes, effort regulation and goal setting had comparable effect sizes that were both larger than time management. For the learning strategies reported to be used more by students who failed the exam, only critical thinking and peer learning had statistically significant differences (highlighted in **red**) with small effect sizes for both. In this case critical thinking had a bigger effect than peer learning.

Table 4.3: Self-Regulated Learning Scores by examination performance.

Learning strategies	Exam performance	Mean	t-value	p-value	Cohen's *d*
Effort regulation	Fail	12.19	**3.85**	**.000**	**0.41**
	Pass	13.13			
Goal setting	Fail	13.95	**3.74**	**.000**	**0.40**
	Pass	15.13			
Time management	Fail	9.49	**3.03**	**.003**	**0.32**
	Pass	10.32			
Critical thinking	Fail	11.80	**-3.18**	**.002**	**-0.34**
	Pass	10.72			
Peer learning	Fail	8.189	**-2.37**	**.018**	**-0.25**
	Pass	7.480			

Reported use of learning strategies in terms of semester test performance

The same analysis was performed on the three semester tests that were offered during the course of the semester. This analysis was carried out to explore whether there was any similarity between the learning strategies associated with passing semester tests and those associated with passing the exam; thus, the three major formal tests were chosen. Semester test 1 only covers analytical chemistry, semester test 2 covers mostly physical chemistry with a small section on organic chemistry, and semester test 3 only covers organic chemistry. Given the different sections of chemistry evaluated in each assessment, such an evaluation could have revealed differences in the learning strategies needed for the different sub-disciplines of chemistry. Independent t-tests were used to compare the reported use of learning strategies by students who passed and students who failed the semester tests. Learning strategies that had statistically significant differences were noted and are shown in **Table 4.4**.

Table 4.4: Learning strategies reported to be used more by students that passed the semester tests

Learning strategies	t-value (p-value)		
	Semester test 1	Semester test 2	Semester test 3
Effort regulation	3.07 (0.002)	5.16 (0.000)	4.51 (0.000)
Goal setting	2.95 (0.003)	5.53 (0.000)	3.61 (0.000)
Time management	2.65 (0.008)	4.11 (0.000)	2.41 (0.016)
Environment structuring		2.76 (0.006)	

Students who passed the semester tests reported more frequent use of the learning strategies of effort regulation, goal setting, and time management, with statistically significant differences for all three semester tests. However, there was an additional learning strategy of environment structuring that was reported to be used more by students who passed semester test 2 and showed statistically significant results. Appendix C contains full tables presenting the results of the independent t-test analysis for the three semester tests.

Reported use of learning strategies in terms of performance subgroups

It was found that LTP students had the highest mean scores for effort regulation, goal setting, task strategies, time management, and environment structuring, while AR students had the lowest mean scores, with MM in the middle. However, AR students had the highest mean scores for rehearsal, organization, critical thinking, peer learning, and help seeking, while LTP students had the lowest mean scores, with MM in the middle (see **Table** C5 in Appendix C).

Table 4.5 shows selected ANOVA results for learning strategies that showed statistically significant differences between the subgroups of AR, MM and LTP. In this case, the eta-squared (η^2) metric was used to estimate effect sizes for the ANOVA. According to Khalilzadeh and Tasci (2017) eta-squared (η^2) metric is used to estimate effect sizes for the ANOVA. Effect sizes of 0.01 to 0.06 are considered small, effect sizes of 0.06 to 0.14 are considered medium, and effect sizes greater than 0.14 are considered large (Khalilzadeh & Tasci, 2017). Effort regulation, goal setting, time management, critical thinking, and peer learning all showed statistically significant differences between subgroup means in ANOVA as well as small effect sizes. However, it is worth noting that effort regulation and goal setting had comparably bigger effect sizes as compared to the rest of the learning strategies. The Tukey post hoc test revealed no statistically significant differences in critical thinking between performance subgroups, which makes sense given the ANOVA p-value of 0.046, which is close to 0.05. However, there were statistically significant differences in effort regulation between AR and MM, AR and LTP, and MM and LTP. For goal setting, statistically significant differences were between AR and LTP, and MM and LTP. Only AR and LTP had a significant difference in time management and peer learning.

Table 4.5: Self-Regulated Learning Scores by Performance subgroups

Learning strategies	Sub groups	Mean	F	Sig.	η^2	Tukey *post hoc* sig.		
						AR & MM	MM & LTP	AR & LTP
Effort regulation	AR MM LTP	12.04 12.68 13.80	11.20	.000	0.051	**0.019**	**0.016**	**0.000**
Goal setting	AR MM LTP	13.86 14.46 16.08	9.744	.000	0.044	0.119	**0.006**	**0.000**
Time management	AR MM LTP	9.491 9.911 10.65	3.786	.023	0.018	0.258	0.240	**0.027**
Critical thinking	AR MM LTP	11.85 11.33 10.60	3.095	.046	0.015	0.255	0.398	0.061
Peer learning	AR MM LTP	8.333 7.769 7.075	4.238	.015	0.020	0.126	0.341	**0.026**

4.5 CORRELATIONS BETWEEN EXAM PERFORMANCE AND LEARNING STRATEGIES

Pearson's correlation coefficients were used in this study to determine the relationship between exam performance and various learning strategies. A Pearson's correlation coefficient is a test statistic that determines the strength and direction of a linear relationship between two variables. It has a range of 0 to 1, with lower values closer to 0 suggesting weak correlations between variables and higher values closer to 1 indicating strong correlations. Depending on whether there is a positive or negative correlation, the values can be positive or negative. A correlation coefficient of 1 indicates that for every positive increase in one variable, a fixed proportion of the other increases as well. A correlation coefficient of -1 indicates that for every positive increase in one variable, a fixed proportion of the other decreases. Zero means that for every increase in one variable, there is not a positive or negative increase in the other, that is, there is no linear relationship between variables. (Pearson, 1896; Benesty, Chen, & Huang, 2008).

Weak but statistically significant positive correlations were found between exam performance and learning strategies of effort regulation, goal setting, time management and environment structuring. A weak but statistically significant negative correlation was found between exam performance and critical thinking. The results are given in **Table 4.6**.

Table 4.6: Correlation coefficients between exam performance and learning strategies.

Subscale	Correlation coefficient
Goal setting	**.25****
Effort regulation	**.22****
Time management	**.15****
Environment structuring	**.13****
Task strategies	.03
Metacognitive self-regulation	.02
Elaboration	.01
Organisation	-.07
Peer learning	-.07
Rehearsal	-.08
Help seeking	-.08
Critical thinking	**-.14****

** - Correlation is significant at the 0.01 level (2-tailed).

4.6 DISCUSSION OF RESULTS

The purpose of this study was to investigate the reported use of learning strategies in a first-year chemistry course that was taught online due to the Covid-19 pandemic and to identify learning strategies that were associated with success in the course. Success in the course was defined as a student's ability to achieve an exam mark of 50% or higher, whereas poor performance was defined as 49% or lower. The reported use of learning strategies by students who passed the exam and those who failed the exam were compared. Learning strategies associated with success were identified as those that were reported to be used significantly more by students who passed the exam. Three performance subgroups based on the third semester test were also considered: AR, MM, and LTP. When the subgroups are examined separately, and especially when the MM is excluded, the LTP subgroup emerges as the most academically strong, as evidenced by the CHAID analysis (**Figure 4.2**); thus, learning strategies reported to be used more by this subgroup of students are important. Correlations between exam performance and learning strategies were also considered to aid in the identification of learning strategies associated with success.

It was found that effort regulation, goal setting, and time management were learning strategies reported to be used more often by students who passed the exam, and there were statistically significant differences between exam pass and exam fail students, suggesting that these learning strategies were associated with success. LTP students reported more frequent use of effort regulation, goal setting, and time management than MM and AR performance subgroups. Exam performance and the learning strategies of effort regulation, goal setting, time management, and environment structuring were found to have statistically significant positive correlations. Therefore, effort regulation, goal setting, and time management were identified as learning strategies associated with success in this study. The findings are consistent with those of Broadbent and Poon (2015) and Broadbent (2017), who discovered that effort regulation and time management are related to good performance in an online learning environment. Zimmerman (2000) also emphasized the significance of goal setting for academic success. In a study conducted by Yusuff (2018), goal setting was also linked to improved performance. Items that comprise effort regulation were about perseverance and

working hard to complete course tasks, even if the tasks are difficult and uninteresting. The items for goal setting were about setting goals for small activities in the course as well as goals for the overall course, and the items for time management were about scheduling study time and using it effectively. The findings indicate that students' ability to push themselves, plan their work, set goals for themselves, and manage their time effectively may have contributed to their success in the course, as these learning strategies were reported to be used more often by successful students. It is also worth noting that the entire sample had a positive overall response to the items that comprise these learning strategies (see **Table 4.2**), implying that students who did not pass the course exam also reported using effort regulation, goal setting, and time management to some extent, but less often than the successful students. We propose that decision of successful students to persist in using these learning strategies a little more often than unsuccessful students may have worked in their favour and made the difference between passing and failing the course exam.

The findings also revealed that students who failed the exam reported using critical thinking and peer learning strategies significantly more than students who passed the exam. The following discussion will first focus on critical thinking, then peer learning will be discussed in the paragraph that follows. Critical thinking was also reported to be used more by AR students, but no statistically significant differences were found between any of the performance subgroups. Some studies have associated critical thinking with good academic performance (Ghazivakili, et al., 2014; D'Alessio, Avolio, & Charles, 2019) and this is in disagreement with the results from the present study where unsuccessful students reported using it more than successful students. For instance, Soodmand Afshar, Rahimi, and Rahimi (2014) discovered that critical thinking was a stronger predictor of academic achievement than autonomy and instrumental motivation in a study of English students in Iran. Bauwens and Gerhard (1987) discovered that critical thinking was highly correlated with students' academic performance in a study with nursing students. We attribute the discrepancy between the findings of the current study and the findings of previous studies to the different context in which critical thinking is investigated. In the current study, the items that comprised the critical thinking strategy concerned the students' ability to use the course material as a starting point to develop new ideas, as well as questioning theories, interpretations, and conclusions presented in the course. We propose that the nature of the course in the present study provided limited opportunities for the use of the items listed under the critical thinking learning strategy. The CMY 127 course is designed in such a way that the information presented in the course is introductory and is about well established foundation models that form the basis of the hierarchical nature of science, better understood for their utility requiring no questioning or interrogation. Furthermore, the overall reported use of the learning strategies for the entire sample revealed that most students did not endorse the items that comprise critical thinking, emphasizing the point that the nature of the course, combined with online learning due to lockdown restrictions, may have made the use of critical thinking skills impractical. As a result, the higher reported use of critical thinking strategies by unsuccessful students may not necessarily imply that critical thinking is associated with poor performance, as both groups (successful and unsuccessful students) reported lower overall use. On the other hand, it is

conceivable that students who performed well on the exam may have stopped using critical thinking strategies listed in the subscale items as it was not helpful in the course and focused on other learning strategies, whereas unsuccessful students may have continued to use these strategies in addition to other learning strategies. It is the opinion of the researcher that the unusual circumstances of the pandemic required students to adapt quickly and rethink how they approach their learning in order to complete the course successfully, even if this meant foregoing learning strategies that have been linked to success in previous research studies. The researcher observes that there could be numerous explanations for why the critical thinking subscale did not function as expected in the current study, and as a result, the researcher suggests this as a possible area for future research.

In terms of peer learning, AR students reported using peer learning more than MM and LTP students, and statistically significant differences were found between AR and LTP. These findings were in disagreement with some studies that found that peer learning was associated with good academic performance (Yu & Richardson, 2015; Uzezi & Deya, 2017; Lim, Ab Jalil, Ma'rof, & Saad, 2020). Although the context of the present study is different, Uzezi and Deya (2017) discovered for a face-to-face learning environment that students who are capable of working in groups and learning with peers performed better in scientific courses. Temitope and Christy (2015) reported that peer learning improves students' academic achievement because students in the same class have more opportunities to study together, and this collaborative learning behaviour aids in their academic achievement. Given the context of the current study, where learning occurred online and students were not permitted on campus, peer-to-peer interactions were not as easy to facilitate and possibly not nearly as effective because students were isolated in their homes due to lockdown restrictions. Furthermore, because the lockdown restrictions prevented students from moving around, opportunities for self-organized peer-to-peer interaction among students were also not possible. It is also possible that AR students reported using peer learning more than MM and LTP students because the AR group had a higher proportion of repeating students and students from an extended program who had already formed peer relationships from previous years. Since repeating and extended program students are generally associated with poor academic performance, their peers were not more knowledgeable and thus their peer-to-peer interactions may have not assisted them. Peer learning was also discovered to be the least endorsed learning strategy among all learning strategies investigated in this study, which is unexpected. However, we presume that the unusual reported use of peer learning was due to online learning combined with pandemic-related lockdown restrictions. This unusual finding on peer learning was further investigated with a follow-up survey to explore the extent to which the lockdown restrictions influenced the use of peer learning, the results of which are presented in Chapter 6.

There are other learning strategies such as organization, metacognitive self-regulation, elaboration, and environment structuring that did not show statistically significant differences between successful and unsuccessful students, but were endorsed by students in the overall sample. It appears that students responded positively to the items that comprise all of these learning strategies (see **Table 4.2**), indicating that these

learning strategies were still reported to be used and may have contributed to the academic performance of the students. We found that the mean score for metacognitive self-regulation was higher for successful students than it was for unsuccessful students although the differences were not statistically significant. This indicates that metacognitive self-regulation may be associated with good performance. This is consistent with previous research where it was found that metacognitive self-regulation is associated with good academic performance (Broadbent & Poon, 2015; Credé & Phillips, 2011; Miller, 2015).

Students who failed the exam reported more use of rehearsal, organization, and help seeking strategies than students who passed the exam. The differences in the reported use of these strategies between successful and unsuccessful students were not statistically significant, however the findings were consistent with previous research. Credé and Phillips (2011) discovered that elaboration, rehearsal, organization, and help seeking were unrelated to good academic performance, which is consistent with our findings, with the exception of elaboration, which was reported to be used more by students who passed the exam. Rehearsal strategies which involve re-reading class notes and memorizing and reciting lists of keywords and concepts may have conferred no advantage because, due to lockdown regulations, students were writing open book tests with no need to memorize and recall items in the course. In terms of help seeking, high-performing students may have felt no need for assistance or may have been discouraged by the isolation caused by online learning, whereas poor-performing students may have realized they needed assistance and thus reported more help-seeking behaviour than the successful students, however, even for this group the strategy was underutilized.

One other learning strategy that was underutilised was task strategies. Items that made up task strategies were about participating on the discussion board and in live virtual lectures by asking questions and taking notes, as well as doing extra tutorial problems to master the content. These items represent the foundation of how students can actively participate in online learning. However, it is understandable that most students would struggle with this learning strategy because students had to adapt to using an online platform for both attending lectures and asking questions. This learning strategy was also investigated further with a follow-up survey, the results of which are presented in Chapter 6.

4.7 SYNTHESIS

This chapter began with an overview of the statistical analysis performed in the SPSS and progressed to present the overall exam performance of the sample as well as exam performance by sample demographics. Overall, the sample performed poorly on the exam. Learning strategies associated with success were identified as effort regulation, goal setting, and time management due to their frequent reported use by students who passed the course exam. Correlations between exam performance and learning strategies were provided to support the identification of learning strategies associated with success, and the findings were then discussed.

CHAPTER 5: RASCH ANALYSIS

This chapter reports on the application of Rasch analysis to explore the performance of the questionnaire used to collect data in this study. This chapter focuses on item fit, differential item functioning, reliability, and item difficulty. Learning strategies associated with success are also identified. The chapter opens with a brief overview of the Rasch model and the subsections that follow present the results in relation to the above-mentioned focal points. The chapter concludes with some general comments on the overall performance of the instrument and learning strategies associated with success.

5.1 THE RASCH MODEL

The Rasch model was developed by the Danish mathematician, George Rasch (Wolins, Wright, & Rasch, 1982). It is a powerful model for the analysis and refinement of survey and test instruments. The Rasch model provides numerous tools that enable one to consider issues of validity and reliability in greater detail than normal statistics. It offers a wide scope of techniques to assess the working of an instrument by cautiously investigating items of a test as well as the response of persons to a particular set of test items (Boone & Rogan, 2005).

As mentioned previously in the methodology section, an online questionnaire that consisted of a combination of MSLQ and OSLQ constructs (61 items of which two were added by researchers) was used as an instrument to collect data from students enrolled in a first-year chemistry course (CMY 127) in the fourth quarter of 2020. Completion of the online questionnaire by the students was voluntary, resulting in a convenience sample of 430. The data set had 422 complete records and 8 records with missing responses randomly distributed across items.

RUMM2030 software was used for the Rasch analysis in this study, and since the items featured more than two response options, a polytomous model, particularly the rating scale model (RSM) (Andrich, 1978), was chosen for the analysis. According to the RSM, the distance between thresholds is expected to be the same across all items. The probabilistic midpoint (that is, 50/50) between any two neighbouring categories is known as the threshold. This indicates that for all items, the metric distance between, for instance, the thresholds dividing categories 1 and 2 and that dividing categories 2 and 3 is the same (Tennant & Conaghan, 2007).

5.2 OVERVIEW OF THE RASCH ANALYSIS

This analysis began by evaluating various fit statistics to determine the overall fit of the data to the model for the complete sample. Linacre (2002) posited that data that fits the model constitutes empirical evidence that the basic assumptions of measurement were met and that meaningful inferences can be drawn from estimates of person ability and item difficulty. Overall item fit expressed as chi-square statistics, threshold ordering which reveals whether item categories are functioning as predicted, local independence of items in the form of response dependency, differential item functioning (DIF), person separation index (PSI), and unidimensionality were all explored to determine the overall fit of the data to the model and establish the

reliability and validity of the instrument. If the data satisfies certain requirements, it can be said that it fits the model and that the instrument is reliable and valid, and therefore fit for purpose (Boone, 2016). Person-item maps were also generated to give information about item difficulty and person ability. DIF was used to identify learning strategies that differentiated between students who passed and those who did not pass the exam. Learning strategies that were found to be more strongly endorsed by students who passed the exam were identified as learning strategies associated with success.

To make further inferences, the sample was divided into three groups based on university academic pathway, yielding three subsets of data, to determine which data set best fit the model. This was done because the three groups of students had different experiences prior to joining the module that could impact their experience of the module on which the study is focused. First-time entering students were taking the module for the first time and therefore had only an online experience of university, some were repeating the module and thus had face-to-face learning experience in 2019 and online learning experience in the first semester of 2020, and others had completed a bridging course before enrolling in the module, which also meant that had both types of experience. Therefore, it is possible that these groups of students would respond to the items in different ways. The data was also divided based on other person factors to see if any trends emerged about the whole instrument, individual items, or students' use of self-regulated learning strategies. **Table 5.1** shows the person factors that were included in the Rasch analysis.

Table 5.1: Person factors included in the final Rasch analysis

History	First-time entrant (*n* = 295)	Repeater (*n* = 62)	Ext Programme (*n* = 73)			
Gender	Male (*n* = 118)	Female (*n* = 312)				
Home Language	English (*n* = 150)	Non-EFL (*n* = 278)				
Grade 12 Phys Sci	Above 81% (*n* = 94)	72 – 81% (*n* = 138)	Below 72% (*n* = 196)			
Grade 12 Maths	Above 89% (*n* = 15)	80 – 89% (*n* = 57)	70 – 79% (*n* = 119)	60 – 69% (*n* = 171)	50 – 59% (*n* = 65)	40 – 49% (*n* = 1)
Exam pass	Yes (*n* = 134)	No (*n* = 252)	Did not write (*n* = 44)			

5.3 COMPLETE SAMPLE (*n* = 430)

5.3.1 Fit statistics

Data entry errors, instrument administration errors, unclear item phrasings, and the likelihood that an item taps into dimensions other than the underlying construct being assessed are some of the reasons why items misfit (Smith & Plackner, 2009). Through Rasch analysis, it is possible to explore the fit of data to the preferred Rasch model. A cluster of fit statistics was examined for the instrument as a whole and for persons and items individually. When an item elicits responses that consistently differ from what the Rasch model predicts, it is labelled as misfitting. Misfits of either item or person responses are regarded as irregularities

that need to be investigated further. For this study, elimination of misfitting items was possible because the main purpose of conducting a Rasch analysis was to explore the performance of the data collection instrument which in turn might lead to the refinement of the instrument.

The overall fit statistics obtained for the first analysis (Baserun) indicated that the data did not fit the Rasch model (total item chi-square = 694.036, df = 366, probability = 0.0000). The chi-square values represent the average difference between observed and expected responses to the items on the instrument. When the probability is less than 0.05 as a first estimated cut-off value criterion, a high chi-square value indicates that a number of responses are not compatible with the model. The probability value indicates the likelihood of obtaining such a high chi-square value by chance alone (Retief, Potgieter, & Lutz, 2013). Therefore, in our case the data did not fit the model. Two items, TS2 (*I read aloud instructional materials posted online to fight against distractions*) and PL4 (*I do not have anyone with whom I can discuss the material that I am learning in this course. (Reverse coded)*) were flagged for misfit. The probable causes of this observation and the approaches taken to resolve it will be discussed next.

Item characteristic curve

The first possible cause that was investigated was poor discrimination. Item characteristic curves (ICC) were used to explore whether items discriminated between the skilled self-regulators and the poor self-regulators. The ICC plots the probability that an item is endorsed or answered correctly against the person's underlying ability on the trait being tested (in our case self-regulation), with the person's ability on the x-axis and the predicted value as a probability of endorsement on the y-axis. The respondent's propensity to endorse statements is shown by the individual position; the more positive the person location, the more enthusiastic the endorsement (Retief, Potgieter, & Lutz, 2013). In this analysis the observed responses from the data set were divided into 7 groups of strength of endorsement, and the corresponding subset mean values were plotted on the ICC for each test item. When observed responses match predicted scores, then the category mean values will fall on the ICC. As shown in **Figure 5.1** below for item TS2, the means for the seven categories are distributed horizontally rather than along the ICC suggesting that skilled self-regulators and poor self-regulators responded to the item in a similar way. This indicates that this item was not discriminating between respondents according to their level of self-regulation. As a result, TS2 was deleted because it could not be used to draw conclusions regarding the use of SRL strategies.

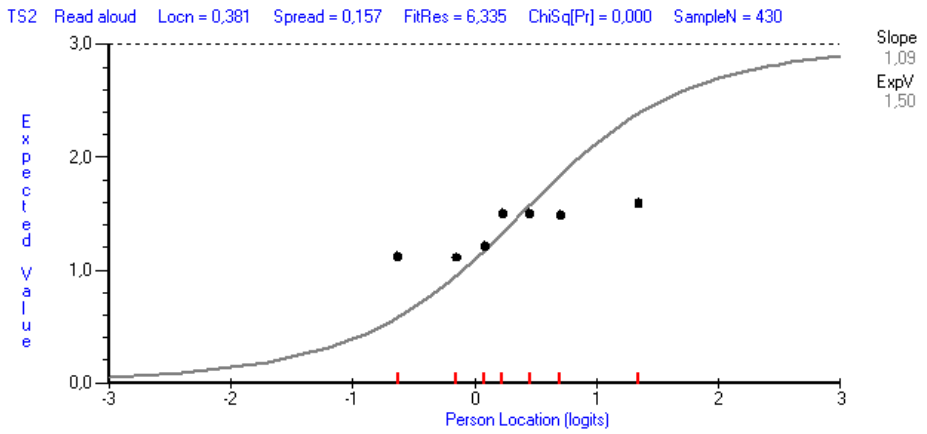

Figure 5.1 ICC plot for item TS2

Threshold ordering

The next possible cause of misfit was explored, namely disorder of response categories. Category probability curves (CPC) are used to illustrate threshold ordering of items. For each item, the probability of choosing individual categories is plotted on the y-axis against a spectrum of person locations on the x-axis (Retief, Potgieter, & Lutz, 2013). The CPC shows whether the response categories on the Likert scale are working properly (Tennant & Conaghan, 2007). In this study the categories are labelled 0 to 3, which corresponds to the scoring convention in RUMM2030 for a 4-point Likert scale. **Figure 5.2a** displays the CPC of Item El2, which shows that all the response categories function as expected, that is, for each of the response categories there is an area of person location where the category is most likely to be selected. In the CPC of Item PL4 (**Figure 5.2b**), however, the curves for the second and third categories, labelled 1 and 2, lie below the other curves in such a way that there is never a region where these categories have the highest probability of being selected. This is considered an irregularity and is likely to contribute to item misfit.

Item PL4 was included in the questionnaire to probe for the extent to which the Covid-19 pandemic had isolated students from their peers. When the category disorder was observed, it made sense that the intermediate categories, unlike the high ends of the four categories, had a lower likelihood of being chosen by the students since the item was probing for whether students had peers with whom to collaborate. Therefore, to resolve the category disorder, item PL4 was rescored from [0 1 2 3] to [0 0 1 1], indicating that it had changed from being a polytomous to being a dichotomous item.

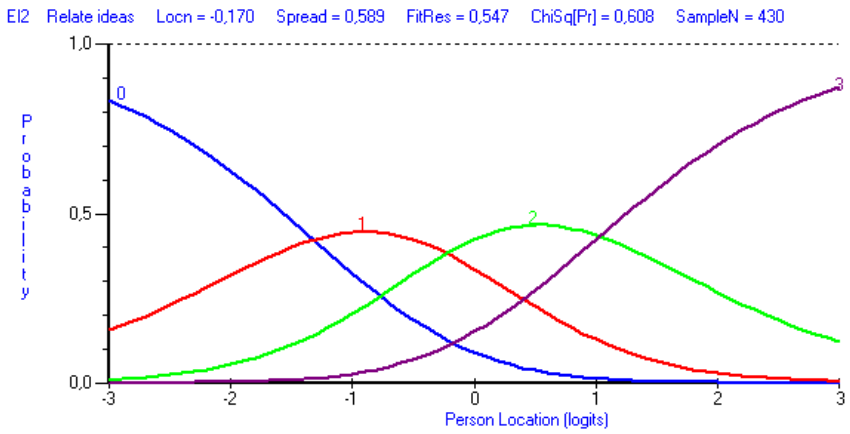

Figure 5.2a: Category probability curves (CPC) plot for item El2

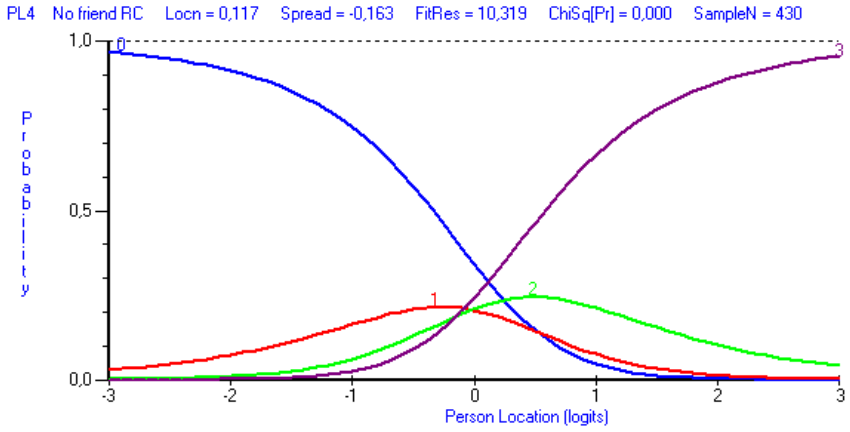

Figure 5.2b: Category probability curves (CPC) plot for item PL4

Nonetheless, even after deleting item TS2 and rescoring item PL4, the overall fit statistics were still unacceptable, and two more items were found to be misfitting with high fit residuals of 4.37 and 4.39. These items were HS1 (*I share my problems with my classmates online (WhatsApp, ClickUP, Facebook, etc.), so we know what we are struggling with and how to solve our problems*) and PL2 (*I try to work with other students from this course to complete the course assignments (virtually or in person) such as class, tutorial, and self-assessment exercises*). The fit residuals indicate how consistently the observed item responses followed the model's predicted values, and these standardised residual values should fall between -2.5 and +2.5 as a rule of thumb (Boone & Rogan, 2005). As a result of the persistent misfit of data to the model, the next step was to examine local independence.

5.3.2 Analysis of local independence

There are two examples of violation of local independence, which may be due to response dependence or multidimensionality. Both types of violations emerge as high correlations between the fit residuals of a subset of items, meaning that some of the items have more in common with each other than the other items. Should

such high residual correlations emerge, the data can no longer fit the Rasch model (Tennant & Conaghan, 2007). This section focuses only on the response dependence, the multidimensionality is dealt with in **section 5.3.5**. An acceptable residual correlation should be <0.4. This analysis revealed high residual correlations between several pairs of items. **Table 5.2** shows some of the high residual correlations that were observed from the analysis as an example.

Table 5.2: Residual correlations observed between items.

Item pairs	Residual correlations
HS1/PL2	0.478
HS2/PL2	0.451
HS2/PL3	0.463
HS1/HS2	0.452
ES2/ES3	0.426

Tennant and Conaghan (2007) suggested that to resolve the misfit due to high residual correlations, items can be combined to form polytomous super-items which would "absorb" the response dependence. These super-items are called subtests in RUMM. The next step was therefore to combine the items per subconstruct into subtests, which resulted in 12 super-items (MSLQ: 7; OSLQ: 5). That is, items were combined into their respective subscales. The overall fit statistics slightly improved (total item chi-square =121.989, df = 72, probability = 0.00022) but two super-items (peer learning (PL) and help seeking (HS)) were still found to be misfitting with high fit residuals of 3.61 and 4.63.

A residual correlation >0.6 between these two super-items was also noted, thus indicating the presence of response dependence and as a result, violating local independence. The two super-items were combined (PL+HS) in an attempt to resolve the local dependence, but fit statistics regressed (total item chi-square =171.249, df = 66, probability = 0.0000); the new item (PL+HS) was flagged as misfitting and was shown to be significantly under-discriminating. The decision was then taken to delete the combined PL+HS item. The overall fit statistics then showed acceptable fit of data to the Rasch model (total item chi-square = 80.708, df 60, prob 0.0386). This means that we had to sacrifice the data on the two subscales, *peer learning* and *help seeking*, in order to ensure that meaningful inferences can be made on the remainder of the data.

5.3.3 Differential item functioning

The fourth characteristic of the data that was explored was differential item functioning (DIF). DIF refers to the observation that subgroups of respondents within a sample may respond in a significantly different manner to an individual item despite equal levels of the underlying characteristic being measured (Retief, Potgieter, & Lutz, 2013). DIF may be an unwanted irregularity if it suggests that one group of respondents is unjustly advantaged over another group with regards to a particular item. For example, if significant DIF is observed between students with and without English as their home language, then it suggests that the wording of the item was understood differently by the two subgroups of students. Such a situation is clearly

undesired. DIF, on the other hand, may provide useful information. For example, if it reveals learning strategies that differentiate between students who passed or failed an exam, we will know which learning strategies were readily favoured by students who passed the exam. DIF analysis involves a process whereby observed responses from each data subset are divided into 7 categories of strength of endorsement, and the corresponding subset mean values are plotted on the item characteristic curve (ICC) for each test item. The subtest data set was further explored for DIF and no significant DIF was observed for any of the person factors included in the data (see the person factors in **Table 5.1**). **Figure 5.3** shows an example of a DIF analysis for one of the person factors, home language, in one of the subscales, *organisation*.

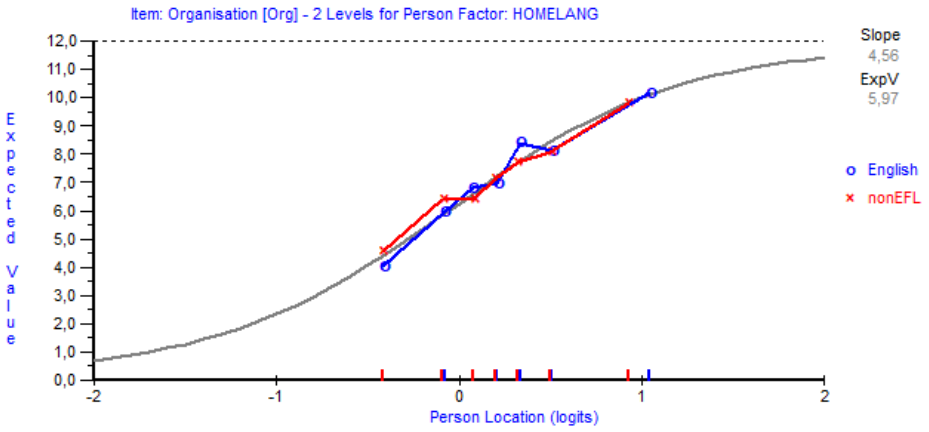

Figure 5.3: ICC plot to illustrate absence of DIF for home language in the subscale, *organisation*

5.3.4 Person separation index

Generally, when reliability estimates of questionnaires are made, a Cronbach's alpha is calculated to express the reliability of an instrument. However, the RUMM2030 software calculates an estimate of person reliability, called the person separation index (PSI). The PSI signifies the ability of the instrument to distinguish between different levels of the underlying construct and is a measure of reliability. The PSI was chosen because it can be calculated with random missing data, whereas Cronbach's alpha can only be calculated with complete data, and since our data had some randomly distributed missing responses, the choice to use PSI was thus justified. The PSI is equivalent to Cronbach's alpha; the only difference is that the PSI uses the logit scale estimates for each individual (linear person estimate) in the calculation rather than the raw scores used for Cronbach's alpha (Tennant & Conaghan, 2007). It is interpreted similarly, in that the numbers range from 0 to 1, with a minimum PSI value of 0.8 deemed appropriate (Wright & Masters, 1982; Prieto, Alonso, & Lamarca, 2003).

Seeing that the PSI value can be inflated by response dependence between items, this value was computed for the data set in which all PL and HS items were deleted, and the remainder were combined in super-items. The PSI for the instrument was found to be 0.89. A reliability index should be at least 0.85 if the data will be used to make decisions about individuals, however if the data will be used to draw conclusions on a group

of students, then the reliability index need only be greater than 0.65 (Frisbie, 1988). The high PSI value computed for our data is a positive result; it resulted in part from good alignment between item endorsability and person ability, due to the presence of multiple thresholds for each item. This will be evident from the person-item map that is presented in the next section (**Figure 4b**).

5.3.5 Unidimensionality

The last characteristic of the data to be explored was that of unidimensionality. Empirical data supported the claim of unidimensionality as follows: the analysis of residual principal components indicated that all Eigen values were below 2.0, and response dependence was reduced to 3.00 or below upon removal of the *peer learning* and *help seeking* subtests.

At this point it was possible to claim that the data fitted the Rasch model and that the ordinal raw score data was transformed to measurement data. The instrument was found to be valid and reliable, indicating that it was fit for the purpose. It was now possible to make meaningful inferences based on the results obtained. The first point of interest was to interpret the Wright map, also known as the person-item map, in terms of the relative difficulty of endorsement of super-items by the students.

5.3.6 Person-item map

The Rasch model has the advantage of being able to simultaneously estimate a person's ability and an item's endorsability (or difficulty) in the same metric. The Rasch analysis software presents these two estimates in a "person-item map". To the right of the vertical line is the item component of the person-item map, with items easiest to endorse at the bottom and those most difficult to endorse at the top. The person component of the person-item map is shown to the left of the vertical line, with those who reported to be least self-regulated in terms of their learning strategies at the bottom and those who reported to be best self-regulated at the top. The person scores are in the same metric as the items, so they can be compared directly (Boone & Rogan, 2005). Item difficulty and person ability are represented in logits (log-odds units), which span from negative to positive values, and these values can be adjusted to fit into a specific range. The item difficulty range was adjusted to -2 to +3 logits in our case, with a set mean of 0 logits. Item endorsability of 0 logits represents a 50% likelihood that a participant with matching ability will positively endorse the item. This hypothetical participant would be more likely to endorse items with negative logit values and less likely to endorse items with positive logit values (Potgieter, Malatje, Gaigher, & Venter, 2009).

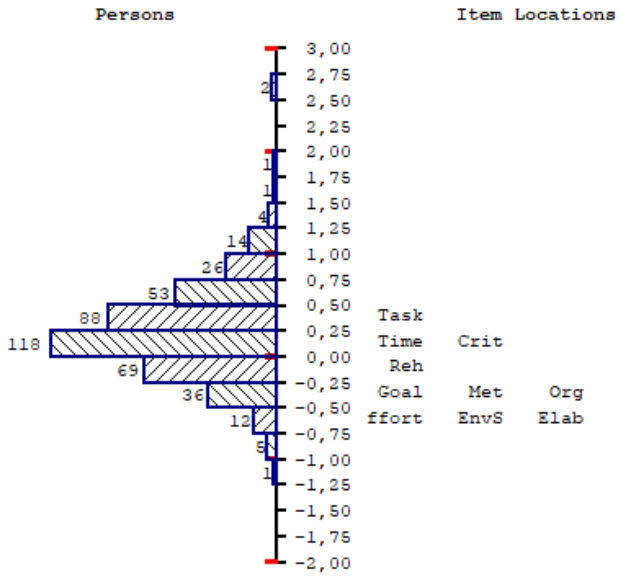

Figure 5.4: Person-item map for a complete sample

Figure 5.4 shows the person-item map for the complete cohort. Effort regulation (ffort), Environmental structuring (EnvS) and Elaboration (Elab) were the easiest to endorse, whereas Task strategies (Task) was the most difficult to endorse. The person ability mean was 0.235 logits and the person abilities of 71% (307 of 430) of respondents were 0.00 or higher. This means that most students found most of the items easy to endorse.

5.4 FIRST-TIME ENTERING SUBSET (*n* = 295)

After achieving fit of the data to the model for the complete data set a similar analysis was conducted for first-time entering students. This was done to investigate whether there were any differences in the fit of data to the model and if the learning strategies associated with success for the subset of first-time entering students differed from those for the complete sample. It was important to conduct this analysis to determine whether students that did not experience contact teaching in their first year at university employed different learning strategies to those that did.

Fit statistics

The base run on this subset of data indicated that the data did not fit the Rasch model. Four items were flagged for misfit: PL2, PL4, TS2 and HS1. PL2 and PL4 were *peer learning* items, TS2 belonged to *task strategies* and HS1 belonged to *help seeking*.

Item characteristic curves

The first possible cause of misfit that was investigated was poor discrimination. Item characteristic curves (ICC) were used to explore whether these items discriminated between the skilled self-regulators and the poor self-regulators. Three of the four items were under-discriminating (TS2, PL2 and HS1), as can be seen in **Figure 5.5** for item TS2.

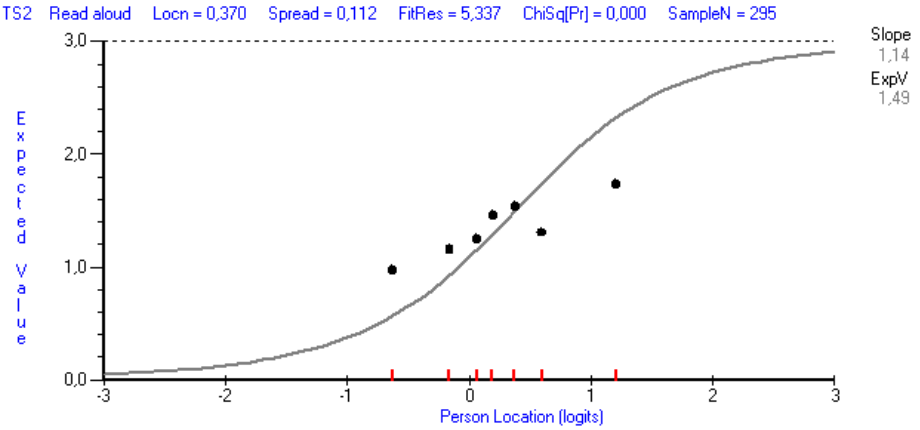

Figure 5.5: Item characteristic curve (ICC) for item TS2

Threshold ordering

As in the complete cohort, item PL4 showed significant category disorder. Again, the middle categories did not function as the model predicted (see the **Figure 5.6** below).

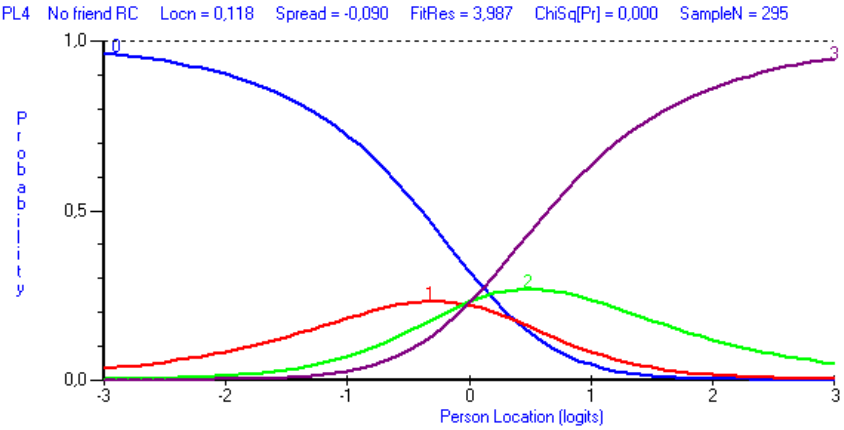

Figure 5.6: Category probability curve (CPC) illustrating category disorder of item PL4

To resolve these misfits in a stepwise fashion, TS2 was removed and PL4 was rescored as a dichotomous item, as was done for the complete cohort, but the overall fit statistics remained unacceptable. Further removal of misfitting items; PL2, PL4 and HS1; in a stepwise fashion did not result in data that fit the Rasch model.

Analysis of local independence

As in the complete cohort, high residual correlations were observed between items that belonged to the *peer learning* and *help seeking* subscales. The decision was then taken to rather follow the steps as was done for the whole sample, that is, to form subtests after deletion of TS2 and rescoring of PL4 to resolve response dependence. The results that were achieved closely resembled what was found for the whole sample. The overall fit statistics slightly improved (total item chi-square = 108.662, df 72, prob 0.00344) but two super-items (PL and HS) were still found to be misfitting with high fit residuals of 3.52 and 4.27. A residual correlation of 0.61 between these two super-items was also noted. The two super-items were combined to

resolve the local dependence, but fit statistics became worse (total item chi-square = 171.249, df 66, prob 0.0000). The new item was flagged as misfitting and was shown to be significantly under-discriminating. This combined super-item (PL + HS) was then deleted and good fit was achieved (total item chi-square = 62.476, df = 60, prob = 0.38834). After the final refinement of the analysis where PL + HS was deleted, the data showed no misfitting items and no residual correlation above 0.4. This meant that, similar to the pattern observed for the complete sample, for first-time entering students we had to sacrifice the data on the two subscales *peer learning* and *help seeking* to ensure that meaningful inferences can be made on the remainder of the data.

Differential item functioning

The misfit of *peer learning* and *help seeking* subscales and the probable cause of it (that is, under-discrimination) indicates that students that were weakly self-regulated reported using peer learning and help seeking strategies more than what the model predicted and students that were better self-regulated used it less than what the model predicted. We propose that this finding can be ascribed to the unique circumstances associated with the pandemic and lockdown, which disrupted the normal situation in which students had a free choice about using or not using these strategies. This means that the responses to items in these subscales were influenced by students' self-regulation as well as other factors; as a result, these subscales were no longer unidimensional and could not be used to measure self-regulated learning. Since the choice to use help seeking and peer learning opportunities was limited, students had to rely on other strategies to cope with the workload and to be successful in the course.

An analysis of patterns of DIF for Exam fail/pass can cast light on the other learning strategies that students had to rely on to be successful in the course. Three subconstructs showed significant DIF between students that either passed or failed the final exam. Students that were successful in the course more readily endorsed effort regulation and goal setting whereas students that failed the exam showed higher endorsement of critical thinking. **Figure 5.7a** and **Figure 5.7b** below demonstrate the presence of DIF for effort regulation and critical thinking respectively.

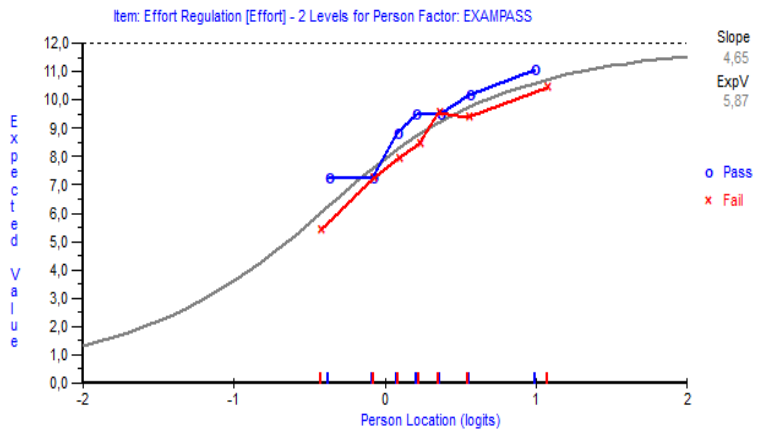

Figure 5.7a: ICC to illustrate presence of DIF for Effort regulation super-item for exam pass/fail subgroups.

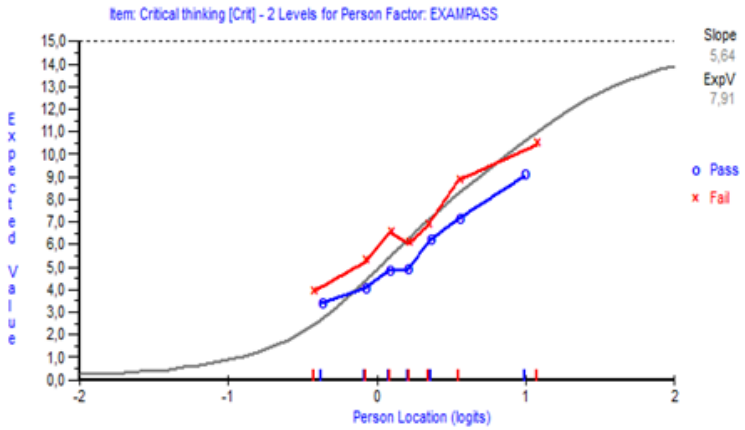

Figure 5.7b: ICC to illustrate presence of DIF for Critical thinking super-item for exam pass/fail subgroups.

Person separation index

The PSI value was computed for this data set in which all PL and HS items were deleted, and the remainder were combined in super-items. The PSI for the instrument was 0.90 meaning that the instrument was just as reliable when only first-time entering students are included in the analysis.

Person-item map

The ranking of endorsability of super-items closely resembles that of the complete sample: Effort regulation (ffort), Environmental structuring (EnvS) and Elaboration (Elab) as well as Goal setting (Goal) were the easiest to endorse for the students, whereas Task strategies (Task) was the most difficult to endorse. The person abilities of 73% (216 of 295) of respondents were 0.00 or higher. This means that most students found most of the items easy to endorse (see **Figure 5.8**).

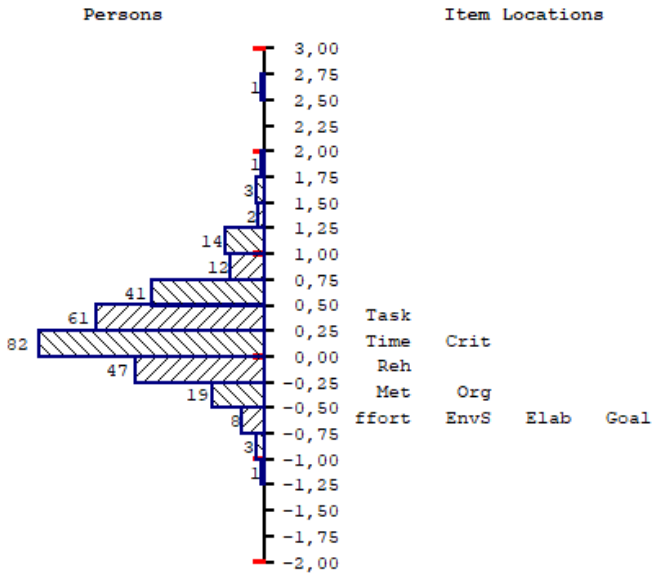

Figure 5.8: Person-item map for a first-time entering cohort

5.5 BSc EXTENDED PROGRAMME STUDENTS (*n* = 73)

After achieving fit of the data to the model for first-time entering students a similar analysis was conducted for extended programme students. This was done to determine whether there were any differences in the fit of data to the model and if the learning strategies associated with success for the subset of BSc Extended programme students differed from those for the complete sample.

Fit statistics

The base run indicated that the data did not fit the Rasch model. Two items were flagged for misfit, because of high fit residuals: GS5 (*I don't compromise the quality of my work because it is online*) and TS2 (*I read aloud instructional materials posted online to fight against distractions*). This result indicates that the responses differed significantly from what the model predicted for these two items.

Item characteristic curve

Both items GS5 and TS2 showed under-discrimination. **Figure 5.9** shows an ICC for item GS5 where it is evident that the response pattern was quite unpredictable. The ICC for item TS2 indicated that it also elicited erratic responses.

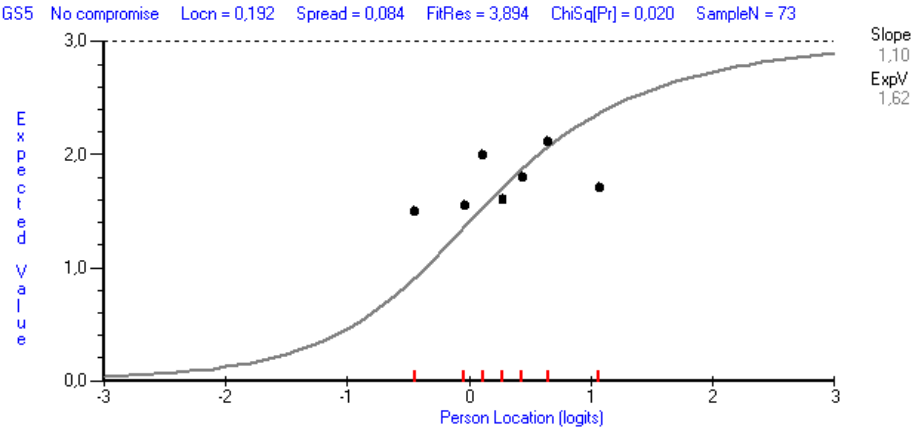

Figure 5.9: Item characteristic curve (ICC) for item GS5

Threshold ordering

As in the complete cohort, item PL4 showed significant category disorder. Again, the middle categories did not function as the model predicted. Similar to the steps for the complete cohort, PL4 was rescored as a dichotomous item and items TS2 and GS5 were removed. At this point overall fit statistics were acceptable (total item chi-square = 374.365, df = 354, prob = 0.192).

Analysis of local independence

Even though acceptable fit statistics were obtained, there was still significant response dependence between nine pairs of items (>0.4). Subtests were then made to resolve response dependence. The overall fit stats were good (total item chi-square = 72.165, df = 72, prob = 0.472), but the residual correlation between HS and PL was 0.57. This necessitated the combination of these two super-items. Different to the previous

analyses, this time the overall fit stats were still good (total item chi-square = 68.282, df = 66, prob = 0.400), so it was not necessary to remove PL+HS. At this stage of the analysis, there were no misfitting items and no response dependence >0.4.

It is a significant finding that PL+HS fitted for this subgroup, while it did not for the first-time entrants. These students had an opportunity to establish peer learning relationships before the lockdown. These two subconstructs function according to expectation, which gives us confidence in the model and the SRL theory on which the instrument is based. Therefore, the fact that PL and HS did not work for the first-time entering students cannot be interpreted as a flaw in the model, but rather evidence for the challenges associated with the context of online learning.

Person separation index

The PSI value was computed for this data set in which the PL and HS items were not deleted, but items were combined to form super-items. The PSI for the instrument was 0.86 meaning that the instrument was still reliable even when only extended programme students are included in the analysis.

Differential item functioning

The analysis revealed that no DIF by gender or home language was observed. In addition, no DIF by Exam Pass was observed as only 10 of 73 students passed the exam.

Person-item map

Environmental structuring (EnvS) was the easiest to endorse whereas a combination of peer learning and help seeking were the most difficult for students to endorse. The person ability mean is 0.187 logits and the person abilities of 70% (51 of 73) of respondents were 0.00 or higher. This means that most students found most of the items easy to endorse (see **Figure 5.10**).

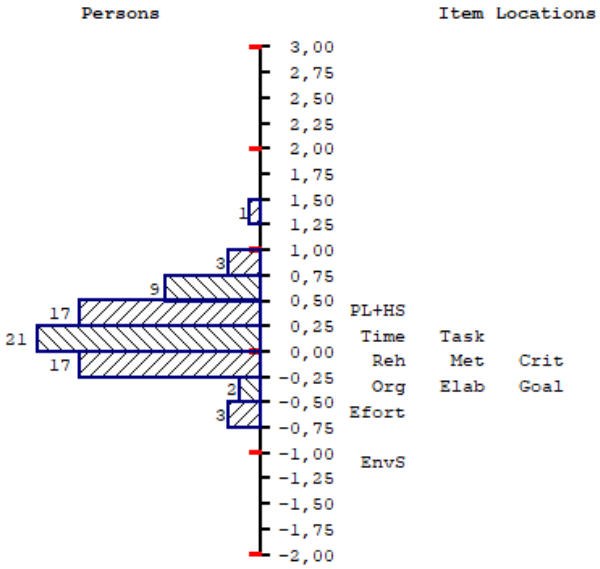

Figure 5.10: Person-item map for a BSc Extended programme cohort

5.6 REPEATING STUDENTS (*n* = 62)

After achieving fit of the data to the model for the extended programme data set a similar analysis was conducted for repeating students. This was done to determine whether there were any differences in the fit of data to the model and if the learning strategies associated with success for the subset of repeating students differed from those for the complete sample and/or the first-time entering students.

Fit statistics

The base run showed acceptable overall fit statistics. Two items had high fit residuals: ER1 (*I feel so lazy or bored when I study for this course that I give up before I finish what I planned to do. (Reverse coded)*) and PL4.

Item characteristic curve

Both items ER1 and PL4 were under-discriminating, but mostly large random deviations from the ICC were observed. **Figure 5.11** below shows ICC for PL4 demonstrating the random deviations.

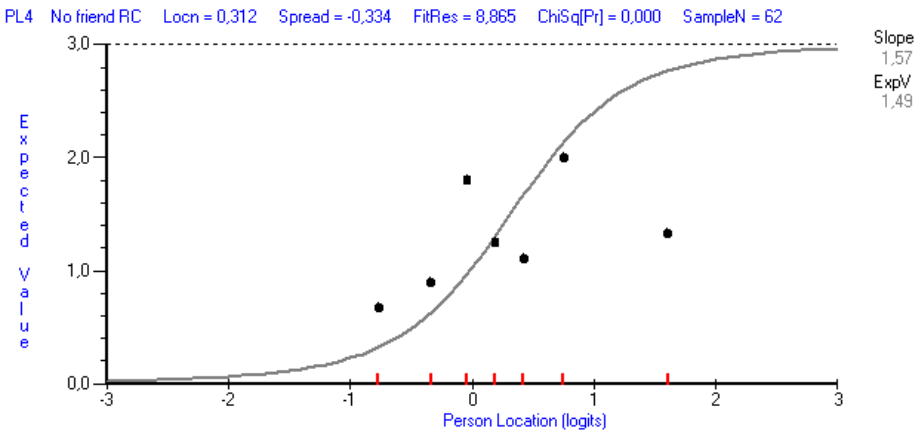

Figure 5.11: Item characteristic curve (ICC) for item PL4

Threshold ordering

Only two response categories of PL4 were operating (similar to the previous analyses) and five other items had one category that was not functioning well. PL4 was rescored as a dichotomous item. The overall fit statistics were acceptable.

Analysis of local independence

The results still showed high fit residuals for ER1 and PL4 even though the fit residual for PL4 was reduced by rescoring. Other possible causes for this observation for PL4 include the fact that the item was under-discriminating and high response dependence was observed between ER1 and PL4 and ten other item pairs. Subtests were then made in an attempt to resolve response dependence. The overall fit statistics were good (total item chi-square = 54.052, df = 48, prob = 0.542), but the response dependence between HS and PL was 0.63. However, when these two super-items were combined the outcome was negative: overall fit stats were no longer good, and the combined item HS & PL was flagged for misfit (high fit residual). The previous

analysis (before the combination of super-items) was therefore the best outcome despite high response dependence. No items were flagged for misfit despite the high fit residuals for HS and PL.

Differential item functioning

The analysis revealed no DIF by gender and home language. In addition, no DIF by ExamPass was observed as only 8 of 62 students passed the exam.

Person separation index

The PSI value was computed for the data set in which super-items PL and HS were not combined. The PSI of the instrument for this subset of students was 0.92 meaning that the instrument was still reliable even when only repeating students are included in the analysis.

Person-item map

Environmental structuring (EnvS), Organisation (Org), Rehearsal (Reh), Effort regulation (Efort) and Elaboration (Elab) were the easiest to endorse whereas peer learning was the most difficult for students to endorse. The person abilities of 50% (30 of 62) of respondents were 0.00 or higher. This means that half of the students found most of the items easy to endorse, except help seeking and peer learning (see **Figure 5.12**).

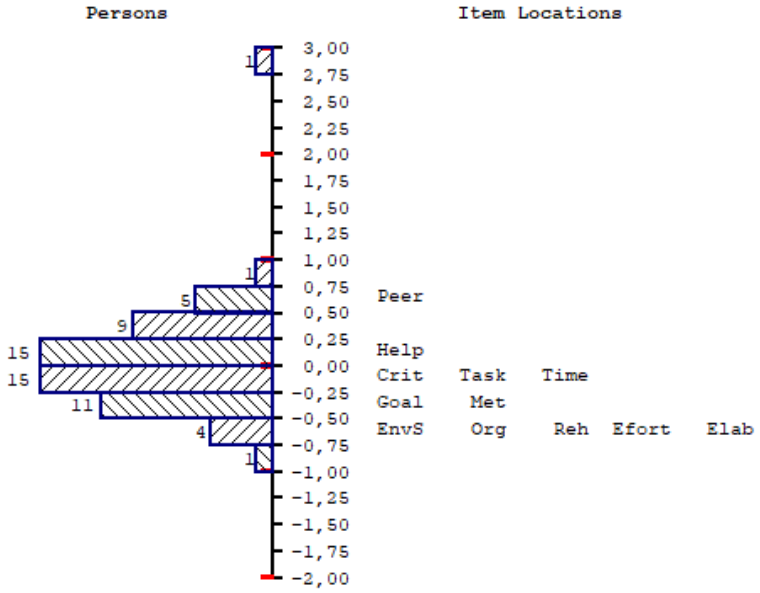

Figure 5.12: Person-item map for a Repeating cohort

5.7 COMMENTS ON INTSRUMENT PERFORMANCE

The results of the Rasch analyses conducted in this study indicate that the response data for one item (PL4) was dichotomous in nature rather than polytomous. This item was then rescored. Several other items solicited erratic responses which were not useful to provide evidence of constructive learning behaviours. These items were deleted. After deleting and rescoring some of the items, it was discovered that the instrument only fit the Rasch model when items were combined to form super-items. Nonetheless, the *peer learning* and *help seeking* super-items were found to be unsuitable for both the entire cohort and the first-time entering cohort, and they had to be combined and eventually deleted. These super-items, however, did not show the same

pattern of misfit for the data sets of the Extended Program and repeaters students. We attribute this finding to the fact that students in 2019 most likely established good peer relationships on which they could rely during lockdown in 2020. As a result, students may have been less affected by external influences in their endorsement of *peer learning* and *help seeking* items than the first-time entering subgroup. From the independent t-tests performed in the SPSS, *peer learning* and *help seeking* were also found to be strongly associated with poor performance, which was unusual according to the theoretical framework that underpins the MSLQ and OSLQ instruments. The "unusual" contextual reality of lockdown imposed several constraints on students, which may have resulted in unexpected results obtained from the *peer learning* and *help seeking* subscales. Although the MSLQ and OSLQ were designed to assess students' self-regulation, external factors influenced response patterns towards SRL in our study. We do not consider this to be a flaw in the instrument; students had to adjust to fewer opportunities for *peer learning* and *help seeking*. Furthermore, there was no unwanted DIF by gender or home language, indicating that no subgroup of students interpreted any of the items differently from the others. We conclude that, overall, raw score data were successfully converted to measurement data, allowing reliable inferences to be made. The instrument was deemed suitable for its purpose, but only after sacrificing some of the items as well as the two subscales of *peer learning* and *help seeking* in the cases of the whole group and the first-time entering subgroup.

5.8 LEARNING STRATEGIES ASSOCIATED WITH SUCCESS

DIF was used, as previously stated, to find learning strategies that differentiated between students who passed and those who did not pass the exam. This allowed the researcher to identify learning strategies associated with success. Only first-time entering students were used for DIF analysis by Exam pass because they had no prior university experiences and could thus provide insight on what learning strategies were associated with passing the exam in an online learning environment during a pandemic without drawing on other experiences of being at a university. When the reported use of the learning strategies was compared for the two groups of students (pass versus fail) it was discovered that those who passed the exam endorsed learning strategies of effort regulation and goal setting more than those who failed the exam. On the other hand, those who failed the exam endorsed critical thinking more than those who passed the exam. This is consistent with the findings from independent t-tests and ANOVA performed in the SPSS, where good academic performance was associated with effort regulation and goal setting, that is, good performance was associated with students' ability to control their effort, push themselves, set goals and plan their academic work. Time management was also associated to good academic performance in SPSS, but the difference was not statistically significant according to the Rasch analysis. However, items on time management were readily endorsed by students who passed the exam. Therefore, it is worth noting that effective time management was also associated to success to some extent. Thus, it can be concluded that learning strategies associated with success were effort regulation, goal setting and time management.

In terms of endorsability, most students found the items easy to endorse. One of the learning strategies that was the easiest to endorse was effort regulation. This could imply that there were no barriers restricting

students from using this learning strategy, and that those who did not use it did so of their own accord. However, task strategies were consistently the most difficult to endorse as a learning strategy. Items that made up task strategies were about participating on the discussion board and in collaborative sessions by asking questions and taking notes, as well as doing extra tutorial problems to master the content. Peer learning and help seeking items were also difficult to endorse for the extended program and repeaters. These findings are consistent with the findings from the statistical analysis performed in the SPSS, which revealed that these three learning strategies had the lowest frequencies of students selecting the categories of "mostly true of me" and "very true of me". Low frequencies of positive responses and association with poor performance from statistical analysis in SPSS, and consistent misfit to the Rasch model necessitated further investigation of these learning strategies by means of a qualitative follow-up survey to probe the extent to which the lockdown regulations impacted the use of these learning strategies, the results of which are presented in chapter 6.

5.9 SYNTHESIS

This chapter started with an overview of Rasch analysis, which was used to investigate the performance of the questionnaire used to collect data in this study. The instrument was found to be valid and fit for purpose after some items, including the *peer learning* and *help seeking* subscales, were removed from the questionnaire. DIF was used to determine learning strategies associated with success by distinguishing between students who passed the exam and those who did not pass the exam. The learning strategies included effort regulation, goal setting, and, to a lesser extent, time management.

CHAPTER 6: FOLLOW-UP SURVEY RESULTS

This chapter presents the findings of a follow-up survey in which the learning strategies of peer learning, help seeking, and task strategies were investigated further to determine the reasons for the unusual under-reported use of these learning strategies. The chapter begins with a brief explanation of how the three learning strategies were selected, as well as an overview of the questions that were asked. The chapter then continues to present the results before concluding with a discussion of the findings.

6.1 OVERVIEW OF THE FOLLOW-UP SURVEY

Statistical analysis in the SPSS revealed the items of the peer learning, help seeking, and task strategies subscales were reported to be least used learning strategies. When items were combined into super-items, peer learning and help seeking, demonstrated a continuous misfit to the Rasch model in the Rasch analysis, and task strategies was the most difficult learning strategy to endorse on the person item map. Furthermore, the statistical analysis in the SPSS also revealed that individuals who failed the exam reported more use of the peer learning and help seeking learning strategies than those who passed the exam. As a result, the unusual and unexpected reported use of peer learning and help seeking, as well as the difficulty of students endorsing task strategies, prompted a follow-up survey to further investigate students' impressions of these three learning strategy subscales.

Peer learning items involve studying and discussing course content with peers, whereas help seeking items involve seeking assistance when faced with unclear or difficult-to-understand content. Task strategies items include using the discussion board to ask questions, taking thorough notes, and doing extra tutorial problems to master the content. Students were asked to elaborate on their reasons for using or not using these learning strategies so that the researcher could gain insight into the unusual, reported use of these learning strategies and could determine whether the reasons were associated with the lockdown regulations. Students were also asked to make suggestions for how the course structure could be changed in the future to allow for a more effective use of these learning strategies. Appendix A contains a list of follow-up questions sent to students through email.

Students who participated in the follow-up survey were purposefully selected according to how they responded to the items that make up the peer learning, help seeking and task strategies subscales. For each subscale, students who responded with "not at all true of me" or "seldom true of me" for all items that make up that subscale were asked to participate in the survey. Students who responded with "mostly true of me" or "very true of me" for all items were also asked to participate; this was because we wished to obtain different perspectives on how the lockdown regulations may have affected students' use of these learning strategies.

6.2 DEMOGRAPHICS

The demographics of the subsample for the follow-up survey are shown in **Table 6.1** along with the demographics of the entire sample and the population. The follow-up survey was completed by 30 students,

19 of whom were female. The subsample was mostly made up of first-time entering students, with only one extended program student and two repeating students. Half of the subsample indicated English as their first language; additionally, half of the subsample passed the exam. 14 students responded under the peer learning strategy, and three of the 14 students endorsed the items that comprise the peer learning strategy. Only two of the ten students who responded under the help seeking strategy endorsed the items that comprise the help seeking strategy. Finally, while six students responded under task strategies, only one student endorsed the items under task strategies.

Table 6.1: Demographical characteristics of the sample.

Characteristics	Categories	*n* (out of 30)	*n* (out of 430)	N (out of 1370)
Gender	Female	19 (63%)	312 (73%)	932 (68%)
	Male	11 (37%)	118 (27%)	438 (32%)
History	First-time entering	27 (90%)	295 (69%)	931 (68%)
	BSc Extended program	1 (3%)	73 (17%)	220 (16%)
	Repeaters	2 (7%)	62 (14%)	219 (16%)
Home language	English	15 (50%)	150 (35%)	493 (36%)
	Non-English	15 (50%)	278 (65%)	877 (64%)
Examination performance	Fail	15 (50%)	252 (69%)	795 (58%)
	Pass	15 (50%)	134 (31%)	397 (24%)
	Did not write		44 (10%)	178 (13%)

6.3 RESULTS

The questions from the follow-up survey will be used as a guide to outline the results for each learning strategy. The responses to the questions were coded for the entire subsample, and the codes for each question were grouped into themes and given definitions. The respective themes and definitions, as well as student quotes, will be presented immediately following each question. When quotes are presented, pseudonyms are used, and other information about the student is provided, such as academic history, home language, and whether they passed the exam. The characteristics were attached to the pseudonyms to provide the reader with some information about the students quoted. Given that most participants did not endorse the items that comprise these three learning strategies, the results will be reported primarily based on responses from students who did not endorse the learning strategies; however, if a quote or a theme was derived from responses from students who did endorse these learning strategies, it will be clearly indicated for the reader.

6.3.1 Peer learning

From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

Working independently

Five students stated that they preferred to study chemistry independently and that they did not feel the need to study with their peers. One student believed they are more productive when they study alone.

"…I honestly like working by myself and find it easier to understand the work when I do it myself… however I realized that this method of studying was not always effective and in future will try to work with others" ~ **Mandla** (first-time entering, murky middle, non-English, exam failed)

"…since chemistry is a subject I tend to do well in I never really felt the need to reach out for help from classmates. Secondly, I find for me personally, I tend to develop a better understanding for a subject if I work on it on my own at my own pace…" ~ **Sofia** (first-time entering, English, exam passed)

"I did not feel as though it was necessary to work with classmates. All troubles I had were easily resolved through simply reading the textbook or perhaps finding an alternative source on the internet" ~ **Peter** (first-time entering, English, exam passed)

Isolation due to the pandemic

Students were required to attend classes online from their homes due to the unexpected shift to online learning caused by the pandemic. At least five students stated that they did not collaborate with their peers because of the isolation. Students indicated that they were unfamiliar with their peers and that they never had the opportunity to establish relationships in class hence, they could not facilitate peer learning.

"I didn't work with classmates because I really didn't know my classmates" ~ **Naledi** (first-time entering, non-English, exam failed)

"The pandemic made it impossible to study with friends. Before lockdown my friends and I tried peer learning once a week." ~ **Violet** (first-time entering, English, exam passed)

"…I did not have the chance to make friends prior to the lockdown and thus couldn't network with other students and form study groups." ~ **Mandla** (first-time entering, non-English, exam failed)

Fitting in with peers

Some students were reluctant to collaborate with their peers due to personal characteristics that made it difficult for them to '*fit in*'.

"…I have ADHD which makes it a lot harder for me to study and work in general…" ~ **Palesa** (first-time entering, non-English, exam failed)

"…I already find it difficult to start conversations with people physically, online learning didn't do much justice to me…" ~ **Naledi** (first-time entering, non-English, exam failed)

"…I am 26 years old...I struggled to make a connection with some of the other students as I felt the age gap was too significant to form a strong bond…" ~ **Thandekile** (first-time entering, non-English, exam failed)

Understanding content and confusion

One Student stated that they were often confused and unsure about what they understood. As a result, they were unable to reach out to their peers for collaboration. The student also stated that they believed their

classmates were just as confused as they were, and that studying with them would not yield positive outcomes.

"…I often did not work with others because I myself am uncertain about what I truly understand or what is it exactly that confuses me in this module. Everything is mixed up. Secondly, my peers seem equally as confused as me at times …" ~ **Brenda** (first-time entering, English, exam failed)

Lack of motivation from peers

Brenda also felt that her peers lacked interest and motivation to learn, therefore she opted to study independently.

"I've reached out once or twice but the lack of enthusiasm combined with my introverted nature led to me studying on my own" ~ **Brenda** (first-time entering, English, exam failed)

Lack of data and internet connectivity

Students come from different areas with varying levels of network connectivity, with some locations having inadequate network connections. Furthermore, data prices are high, and some students are unable to afford it. As a result, Muzi found it difficult to connect with his peers through online platforms.

"I did not have enough data, nor a good enough connection to allow video calls to friends." ~ **Muzi** (first-time entering, non-English, exam passed)

How useful would it be or was it for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

Better understanding of content

Students believed that interacting with peers would allow them to evaluate their level of understanding of content. Others felt that explaining content to others helps them learn more and encourages them to be thorough in their studies. As a result, students may have a better understanding of the content.

"…help me get a better understanding of the work. Especially because I struggle to think further than the work being taught. I have found that other peoples' questions in class increase my understanding of the work a lot." ~ **Mbali** (first-time entering, non-English, exam passed)

"Peer learning would be beneficial as it would allow me to learn while explaining and would make the study process more engaging and enjoyable." ~ **Muzi** (first-time entering, non-English, exam passed)

Learning from different perspectives

Students believed that peer learning would be beneficial since it allows them to learn content from different perspectives. Students feel that they perceive content in different ways, and that if they get together, they can share their perspectives and learn from one another.

"I think it would be extremely helpful… and also getting to understand things from different perspectives allows for more learning and growth…" ~ **Naledi** (first-time entering, non-English, exam failed)

"I think working together with other students with CMY 127 would be extremely helpful as every person may have a different way of getting to understand the module content." ~ **Thandekile** (first-time entering, non-English, exam failed)

Peer learning as a study method

Peer learning is a study method for some students; they study by collaborating and interacting with their friends or classmates, and some students use it to revise before exams.

"Peer learning has been one of the most important methods of learning I have adopted, even before coming to the University of Pretoria." ~ **Bongani** (first-time entering, non-English, exam failed)

"I think working together with classmates would be beneficial…I find that explaining a solution to a friend helps me to learn" ~ **Violet** (first-time entering, English, exam passed)

Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work with your friends?

Facilitation of interaction

Because peer learning requires peer to peer interaction, and online learning makes this challenging, at least six students suggested that formal online groups for students should be established, either through social media platforms that are easily available to students or through the learning management system. More group assignments that require students to communicate and interact with one another were also proposed by students.

"I think the tutorial groups should be split into smaller groups. A group of students can then work together and then also have a tutor there to help if required." ~ **Violet** (first-time entering, English, exam passed)

"…WhatsApp groups could be created for each tutorial group where questions and answers could be shared under the guidance of a tutor." ~ **Muzi** (first-time entering, non-English, exam passed)

"…I would probably say it would be a good idea to introduce students to a platform where they can interact, both in person and digitally. At the moment the WhatsApp groups come close to this sort of interaction …" ~ **Thandekile** (first-time entering, non-English, exam failed)

"I feel that there is a need for more resources/opportunities for students to practice exam style questions…I think maybe working with other learners in smaller groups on exam style questions could be beneficial." ~ **Lillian** (first-time entering, non-English, exam passed)

Facilitation of learning and revision

Students collaborate to practice exam style questions to prepare and revise for exams. However, the availability of these exam style questions is limited, so students proposed that these questions be made available to them.

"I feel that there is a need for more resources/opportunities for students to practice exam style questions …I enter the semester tests and exams feeling like I know everything well, because I have worked through all the tutorials and class examples but then I score a bad mark on the tests. I think maybe working with other learners in smaller groups on exam style questions could be beneficial." ~ **Mbali** (first-time entering, non-English, exam passed)

6.3.2 Help seeking

From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want).

Study preference

Some students preferred not to seek assistance from instructors or anyone knowledgeable in the topic, preferring instead to sort out their own confusion utilizing materials such as the textbook, online sources, or course materials.

"I prefer to go through the textbook and YouTube videos to try and figure out what I don't understand in my own way." ~ **Anna** (first-time entering, English, exam passed)

"…because when I encounter content that I do not understand my strategy is to look at tutorial recordings, look at answers for OWL assessments, and YouTube videos. I would consider seeking help from other people as my last resort if the previous strategies do not work…" ~ **Sarah** (first-time entering, English, exam failed)

Pandemic related reasons

Students noted how the change to online learning made it difficult for them to seek help from instructors, classmates, or anyone knowledgeable in the content. Some students stated that they did not know how to phrase questions in writing in a way that would get them satisfactory answers, while others who preferred to seek help from classmates felt that they did not get the opportunity to know their classmates.

"I don't have any contacts of my classmates to ask for help from them. I often did not know how to phrase the questions I had to lecturers and our tutors." ~ **Bontle** (repeating, non-English, exam failed)

"I think would mainly be because of the online environment this semester…And if you really do not understand something, you need to be able to express yourself fully, which I feel I could never do through an e-mail or through a message or something like that" ~ **Khethiwe** (first-time entering, non-English, exam passed)

As a result of online learning, students were no longer able to seek help from instructors face-to-face and instead had to rely on emails or the discussion board. Due to the high volume of emails that instructors get from students, responses to students were delayed, discouraging students from seeking help in the future.

"…being in contact with lecturers was convenient…now everyone would be trying to email the lecturers or tutors, then you would not be able to get an immediate response." ~ **Sipho** (Extended programme, non-English, exam failed)

Understanding of content and confusion

Students were often confused by the content, and as a result, they did not know what they were struggling with and thus were unable to seek help. Some students stated that they were often behind on their work and hence were hesitant to request assistance from instructors.

"The main reason I didn't ask for help is because If I didn't understand something, I couldn't pinpoint what I didn't understand. So, I just felt like I didn't understand anything." ~ **Julia** (first-time entering, English, exam failed)

"I feel as though I could not seek help because there was so much I did not know so even if I were to seek help and receive an answer from someone it would be useless/hopeless because I would not understand what was going on…" ~ **Khanyi** (first-time entering, non-English, exam failed)

"I did not ask for help mainly because I felt that I was so behind in my work and asking for help would require me to be knowledgeable of the basic terminologies and content of whichever theme." ~ **Khanyi** (first-time entering, non-English, exam failed)

Personal factors

One student mentioned struggling with personal problems that made it difficult for them to seek help. Another student stated that they were hesitant to seek help from their peers because they did not trust the information their peers would provide, especially because they were in the same class.

"I struggle with social anxiety, and I find it very hard to talk to people specially to ask them questions if I don't know them or have at least some kind of relationship with them. With the online work it was very hard for me to build comfortable relationships with the lectures, tutors, or my fellow students…" ~ **Buhle** (first-time entering, non-English, exam failed)

"I don't trust fellow classmates most of the time…I'm afraid that they would just help me in a wrong manner…if they told me that it was the right way to do the question and then it was actually not the right way and then I would struggle to get out of that method." ~ **Khethiwe** (first-time entering, non-English, exam passed)

Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

Online sources

Students turned to internet resources such as YouTube for assistance.

"I resorted to using YouTube to try videos of some work that I did not understand…YouTube videos were helpful, but they were really time consuming." ~ **Sipho** (Extended programme, non-English, exam failed)

"I often look to videos on YouTube that explain the content, I find that these videos are very helpful." ~ **Anna** (first-time entering, at risk, English, exam passed)

Instructors' developed materials

Instead of seeking help from instructors, classmates, or anyone knowledgeable in the content, students used materials offered in the course to sort out their confusions.

"Looked through the notes on clickUP to see if I missed something then I would find the recorded lecture and see if the Professor says anything not on the notes" ~ **Buhle** (first-time entering, non-English, exam failed)

"The strategy that has helped me the most to understand my work is through re-watching tutorial recordings, the tutors explain the steps really well and also I like that there is a variety of questions that are being done during the tutorial session" ~ **Sarah** (first-time entering, English, exam failed)

Textbook

Some students sought help from the textbooks that were prescribed or recommended to them.

"…I would consult the textbook and just work through everything from start to finish just thoroughly myself." ~ **Julia** (first-time entering, English, exam failed)

"…I would go to my textbook. And I would see if there's any examples of it…" ~ **Khethiwe** (first-time entering, non-English, exam passed)

Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

Which one would be the least useful to you to seek help from? Please explain.

When asked who would be or was the most useful individual to seek help from among tutors, classmates, and lecturers, six out of ten students chose tutors, one chose classmates, and another chose both classmates and lecturers. The remaining two students, on the other hand, believed that YouTube would be the most useful source of help. Most students thought tutors would be the most helpful, followed by classmates, and finally lecturers. Classmates were the least useful, followed by lecturers, and finally tutors. Both questions (least and most useful) were asked to get a sense of how each participant felt about the usefulness of the sources of help listed under the help seeking learning strategy. The following are in essence the reasons

offered by students as to why they thought tutors would be the most useful and classmates and lecturers the least useful.

Reasons why tutors were ranked the most useful.

- They have the fewest responsibilities, as opposed to lecturers, and they have more experience than their classmates.
- They are the least intimidating and knowledgeable in the chemistry content.
- Tutors respond quickly, and students feel free to ask as many questions as they need until they understand. This was also a reason given by the student who felt that classmates were the most useful
- One student who endorsed the help seeking strategy felt that tutors go into greater detail when explaining concepts and emphasize what students should know.

Reasons why classmates were ranked the least useful.

- Because they were learning alongside their classmates at the same time, students felt that the information provided by their classmates would not be accurate, and some students were afraid of being misled.
- One student who endorsed the help seeking learning strategy pointed out that their classmates were often confused and struggling with the same problems.
- Students believed that because classmates lacked teaching expertise, they could not explain concepts as well as tutors or lecturers could.

Reasons why lecturers were ranked the least useful.

- One student felt that lecturers most of the times refer students to tutors.
- Another student highlighted that the lecturers take a while to respond.

Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

Multilingual tutors

The university enrols students from a variety of backgrounds. One of the differences that students experience when they enrol in university is their native language. Some students speak English as a first language, while others speak it as a second or even a third language. Those who speak English as a second or third language often have difficulty phrasing questions to instructors in such a way that they receive satisfactory responses.

"Include diversity in terms of multilingual tutors…as phrasing of questions may sometimes be difficult for students who don't have English as home language." ~ **Bontle** (repeating, non-English, exam failed)

6.3.3 Task strategies

From the questionnaire, your responses indicated that you often did not use the discussion board or collaborate sessions to ask questions, or take thorough notes and do extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

Not needed

Some students stated that the techniques outlined under task strategies were unneeded and thus only used them on rare occasions.

"I did not make use of the discussion boards as I did not feel that there were any specific problems a peer or tutorial could not help me with." ~ **Mokgadi** (first-time entering, non-English, exam passed)

"Personally, I find that listening in the lectures and reading through the notes is enough for me…I can rely on my logical understanding of the content to get me to an answer." ~ **Oliver** (first-time entering, English, exam passed)

Fear of revealing a lack of understanding when others were coping.

Two items of the task strategies involve asking questions during an online lecture and posting questions on the discussion board; however, some students expressed concern about being exposed and embarrassed since their names are associated to the questions they post; therefore, they rarely used the task strategies.

"During lectures I found it hard to ask questions because it feels like I am holding back the entire class." ~ **Nora** (first-time entering, English, exam passed)

"When it comes to asking questions in discussion boards and live virtual lectures, that often relates to a difficulty in asking questions, and almost a fear of it…Some of it obviously relates to ego; asking a question and feeling stupid…" ~ **William** (first-time entering, English, exam failed)

Confusion

One student stated that they were often confused by the content and could not determine what they were struggling with and thus, they could not use the task strategies.

"I never used the mentioned platforms because I struggled with the work, but I never really understood what is was that I struggled with so asking a question would have most likely have been an irrelevant question…" ~ **Carol** (first-time entering, English, exam failed)

Out of the three study habits listed above, which one do you think would be the most useful for improving your learning in CMY 127 and why?

Which one out of the three would be the least useful for improving your learning in CMY 127? Please explain.

When asked what would be or was the most useful study habit among asking questions on the discussion board or in live virtual lecture, taking thorough notes, and doing extra tutorial problems, four out of five students chose doing extra tutorial problems and two chose taking thorough notes. For the question of what would be the least useful, four out five students chose asking questions on the discussion board or in the live virtual lecture and one student chose taking thorough notes. The following are the reasons offered by students as to why they thought doing extra tutorial problems would be the most useful and asking questions on the discussion board would be the least useful.

Reasons why doing extra tutorial problems would be the most useful.

- One student, although they reported not using task strategies, stated that it helped them realize the limits of their understanding of a topic; when they could not answer some of the extra tutorial problems, they realized how much more they needed to study to obtain a better understanding.
- Another student felt encouraged and motivated to make use of the various resources at their disposal to answer the extra tutorial tasks in future.
- According to the one student who reported using task strategies, the extra tutorial problems also helped with exam preparation and revision by serving as practice exam questions.

Reasons why taking thorough notes would be the most useful.

- One student mentioned that taking thorough notes would help one focus in class and not fall behind easily
- Another student stated that taking thorough notes would help them understand content rather than just watching and listening in an online class

Reasons why asking questions on the discussion board was ranked the least useful.

- One student felt that the discussion board served the same purpose as an email.
- Others were concerned about having their lack of knowledge exposed in front of their classmates and instructors because the discussion board is set up as a public forum.
- Other students had trouble formulating their queries in writing.
- One student struggled to keep track of questions posted on the discussion board, making it impossible to establish whether an answer to their question had been posted.

Reason why taking thorough notes was ranked the least useful.

- One student believed that taking thorough notes would be ineffective because writing things down and reading through notes only triggers recognition of the work, which can lead one to believe that they understand the work.

Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

Anonymity on the discussion board.

If a student posts a question on the discussion board or asks a question during an online lecture, the learning management system associates the name of the student with the question. Students are usually fearful of having their lack of knowledge and understanding exposed in front of instructors and their classmates, so they become hesitant to raise questions.

"I think I really, really love the idea of an anonymous discussion board questions, so even yeah, when the pandemic's over and when you go back to normal 127, that maybe they could keep that discussion board open…" ~ **Julia** (first-time entering, English, exam failed)

"One solution to the collaborate or discussion board issue could be anonymity. Allowing people to ask questions without having the question tied to their name." ~ **William** (first-time entering, English, exam failed)

Separation of tutorial questions into categories based on their complexity.

"…to have the tutors give us a separate pack of "challenging" tutorial questions, because I like doing the challenging ones for exam prep and stuff, but usually I have to sift through the standard ones to find them…" ~ **Oliver** (first-time entering, English, exam passed)

Provision of a comprehensive memorandum of tutorial questions.

Although these students reported not using task strategies, they suggested that comprehensive memoranda to the tutorial exercises would help with exam preparations.

"I think CMY127 should definitely consider giving more thorough tutorial memos as this makes it much less time consuming to practice the tutorial questions. I found the tutorial questions extremely helpful just before a test or the exam." ~ **Mokgadi** (first-time entering, non-English, exam passed)

"The only request I could put forward is the release of answers to prescribed questions…" ~ ***Peter*** *(first-time entering, English, exam passed)*

Detailed and timely feedback on assessments

Although students did not directly link this to the peer learning, help seeking or task strategies, they did suggest that receiving timely feedback on their assessments would help them understand what they are doing wrong so that they could try to fix their mistakes while there is still time. Some students stated that the feedback they receive on their assessments indicates how well they understand the topic and what they should focus on for the next assessment.

". I would suggest that in future they try to give assessment feedback much faster." ~ **Mandla** (first-time entering, non-English, exam failed)

"...having our marks on time would help so that we know where we went wrong and have enough time to attempt to fix our mistakes." ~ **Naledi** (first-time entering, non-English, exam failed)

"I think the tutors that mark our practicals/tutorials/tests should comment on our mistakes with a link to email if you done understand why you got the question wrong" ~ **Buhle** (first-time entering, non-English, exam failed)

6.4 DISCUSSION

Historically, most institutions viewed online learning as a nice-to-have alternative, with no pressing need to migrate to it (Ribeiro, 2020), but the unexpected disruption of traditional teaching and learning methods caused by the COVID-19 pandemic changed that. Due to the pandemic, online learning presented several logistical challenges. Not only did it necessitate a shift in attitude among education administrators, instructors, and students regarding the importance of online learning, but it also necessitated students adjusting how they approached their learning activities in terms of self-regulated learning to cope with the new learning model (Adedoyin & Soykan, 2020). We believe this was the case with the students in the current study as the Rasch analysis revealed that the peer learning and help seeking learning strategies did not function as expected. The intriguing finding regarding peer learning and help seeking was that the two learning strategies worked well for students who enrolled at the university prior to the pandemic but did not work as well for first-time entering students. This led us to assume that the combination of online learning and lockdown regulations influenced how students regulated their learning. The purpose of the follow-up survey was to investigate the unusual and unexpected reported use of peer learning and help-seeking strategies, as well as the difficulty of students endorsing task strategies and find out whether it was influenced by online learning in conjunction with the lockdown regulations imposed because of the Covid-19 pandemic.

For all three learning strategies investigated, three common reasons for poor use of these learning strategies emerged: pandemic-related reasons (isolation and lack of resources), comprehension of content/confusion, and choice (study preference). It can be deduced from the themes that online learning because of the pandemic influenced the students' use of these learning strategies, though for some students, not using these learning strategies represented a personal preference. Our findings indicate that some of the students who stated that it was their preference not to use these learning strategies failed the exam; hence, personal barriers and preferences may have had a detrimental impact on the students' performance. Furthermore, reasons related to a lack of adequate resources to engage in successful online learning were expected, as they are part of the known challenges associated with online learning (Adedoyin & Soykan, 2020; Fishbane & Tomer, 2020). Universities across the country attempted to mitigate this challenge by providing laptops and monthly data bundles, but in some areas, particularly rural areas, network connectivity is lacking, rendering these materials ineffective.

Furthermore, the abrupt shift to online learning did not allow higher education institutions the opportunity to prepare content to support peer activities and peer learning technologies to assist when learning occurs online (Mukhtar, Javed, Arooj, & Sethi, 2020). That is, peer learning opportunities were limited in the online learning design, and as a result, students have had to create their own peer learning opportunities which was also a challenge due to the lockdown restrictions that did not allow people to move around. Therefore, students were unable to benefit from cooperative learning, in which students collaborate, each contributing what they can to improve their understanding of a subject. According to the findings, some students attempted to reach out to their peers but were unsuccessful (*"I've reached out once or twice but the lack of enthusiasm combined with my introverted nature led to me studying on my own"* ~ **Brenda** (first-time entering, English, exam failed)). Some students who demonstrated a desire to engage in peer learning but were limited by circumstances failed the exam. Although there is no direct relationship between these students' performance and their lack of peer learning activities, previous research has found a positive correlation between peer learning and good academic performance (Chen, Huang, Chang, Wang, & Li, 2010; Shen, Cho, Tsai, & Marra, 2013; Uzezi & Deya, 2017). As a result, it is possible that a lack of peer learning opportunities impacted the students' performance. Students envisaged how using peer learning could help them learn better. Students believed that by participating in peer learning, they would be able to learn from different perspectives and gain a better understanding of the concepts. This is consistent with the definition of peer learning given by Bound (1998) who stated that peer learning "involves notions of interdependence and mutual beneficial where students share knowledge, ideas and experience" and it is through the sharing of ideas that students learn from different perspectives and get better understanding of concepts. We postulate that when students study together, the discussions that occur stimulate interest in the content, resulting in more learning and better understanding. One student (Mbali) made a proposal for how to improve peer learning in the course; they suggested that having access to prior exam papers would be advantageous while studying with their peers. According to Du Boulay (2011), "what you discover is never as frightening as what you do not know or what you imagine to be the case". We assume that this was the case for our students, who sought to gain a sense of what to expect in an exam. Students, for example, can learn about the expected exam duration, normal number of questions, estimated time required for each question, and key topic areas to focus on in revision by reviewing prior question papers (Du Boulay, 2011).

In terms of help seeking, previous research has demonstrated that better learning benefits can be obtained when students engage in appropriate help seeking behaviours and when instructors give efficient help mechanisms and resources. Furthermore, asking for help has been shown to contribute to a broad pattern of student resilience in overcoming barriers to learning and achievement (Koc & Liu, 2016; Newman, 2002). In this study, students revealed that isolation had an impact on their use of help seeking strategies, which made sense given that asking for help from peers is part of help seeking. It was also discovered that some students who reported not seeking help due to pandemic-related concerns failed the exam. These students expressed a desire to seek help but were hindered by circumstances; it is possible that these students realised

they needed to seek help to enhance their performance but were unable to do so owing to the circumstances of the pandemic. Aside from the effects of lockdown regulations, help seeking in the online environment can be influenced by several elements such as technology, course management system, nature of the course, and student and instructor personalities (Koc & Liu, 2016). This was also consistent with students who stated that they felt more comfortable seeking help from their peers before approaching instructors; thus, it is likely that these students believed that seeking help from their peers posed less of a threat to them in terms of having their lack of knowledge exposed in front of their instructors. For students that reported not seeking help due to personal preference, Koc and Liu (2016) and Butler (2006) highlighted that sometimes a self-regulated learner may avoid seeking help because they strive for autonomous learning. Additionally, some students are likely to seek help if the situation allows them to first attempt to resolve difficulty on their own and the help is supportive of their autonomy in the long run. Furthermore, when students do not seek help, it may indicate that they are unable to construct a legitimate question or are too ashamed to seek help and guidance (Koc & Liu, 2016) and thus end up choosing not to seek help. Students were asked to indicate other places where they sought assistance. The textbook and online sources were the most common resources used by students to seek assistance. Because of the circumstances, it was simpler to use the textbook and search for answers to their questions on their own, establishing independence in their learning, rather than trying to get help from another person.

The themes for task strategies were comparable to those for peer learning and help seeking, but one theme for task strategies stood out: a fear of being exposed to others, that is, having their lack of knowledge or understanding exposed in a public setting. This was because part of the task strategies in this study focused on using the discussion board and live virtual lecture sessions to seek assistance and ask content-related concerns. Students expanded, indicating that they were hesitant to employ these learning techniques because they were afraid of being exposed to their classmates if they posted their questions online. Students felt that being anonymous on the discussion board will assist them in improving their use of this learning strategy.

One common theme that did not relate directly to any learning strategy emerged from the students' suggestions under all three learning strategies. The theme was detailed and timely assessment feedback. According to Hattie and Timperley (2007), the purpose of feedback is to improve learning by giving students information that bridges the gap between their present and intended performance. Feedback, more particularly, represents timely and relevant dialogic information regarding student learning for the purpose of improving student learning (Goodwin & Miller, 2012). This is consistent with the explanations given by the students, who stated that feedback on their assessments would allow them to identify and remedy their mistakes, allowing them to improve their performance. It is crucial to note, however, that the challenge with delivering timely and precise feedback to students may be scalability, particularly in large classes, as in the current study (Higgins, Hartley, & Skelton, 2002). The need to provide timely and personalized feedback to all students results in a large increase in the time and effort required by instructors in producing and providing feedback customized to the requirements of hundreds or thousands of students. As a result, it is important to

automate the process of producing and delivering feedback to students while keeping instructors and other academic staff members' time and effort manageable.

Overall, the findings indicate that the lockdown restrictions influenced the use of peer learning, help seeking, and task strategies. Furthermore, while students are responsible for ensuring that they perform well in their academics, instructors have a role to play in structuring the course in a way that allows students to employ most of the learning strategies that are required for success.

6.5 SYNTHESIS

This chapter began with a rationale for conducting a follow-up survey and then went on to describe the demographics of the participants. Most students who responded to the follow-up survey were first-time entering, which provided the researcher with more insight into the situation of first-time entering students. The exam was passed by half of the individuals who took the follow-up survey. The findings revealed that the lockdown regulations had an impact on the use of peer learning, help seeking, and task strategies. Common themes that emerged from the responses regarding the poor use of the learning strategies were pandemic-related reasons, confusion, and study preference.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

This is the final chapter of the report. In this final chapter, the researcher draws conclusions from the findings and makes recommendations for teaching in the online environment which may pave the way for future research. This chapter begins with an overview of the structure of the study and then presents a summary of the findings. The educational implications of the findings are then briefly discussed, followed by the significance of the study. Following the presentation of areas for further research, the chapter closes with some concluding remarks.

7.1 OVERVIEW OF THE STUDY

The overall aim of this study was to explore students' use of learning strategies during the Covid-19 pandemic while studying online to identify the learning strategies associated with success in a first-year chemistry course. The data for this study were collected during the year 2020, when Covid-19 was widespread, and learning was taking place online. The study focused on a first-year chemistry class and sought to investigate students' use of self-regulated learning strategies to identify learning strategies associated with success. A case study methodology with mixed methods approach was used. The quantitative data were collected first, using a combination of some of the subscales from the learning strategies section of the MSLQ and some subscales of the OSLQ (see section **3.3.2**). This was followed by a collection of qualitative data through a follow-up survey with open-ended questions to provide additional information to the preliminary findings from the results of the quantitative data collected. Both rounds of data collection were conducted online at the University of Pretoria, with the first round using the learning management system Blackboard referred to as ClickUP and the second round using emails. Although student participation was voluntary, 430 students representing the demographics of the class population of 1370 participated in the first round of data collection. This yielded a satisfactory sample to produce credible results. The second round of data collection included 30 students purposively drawn from the 430 sample. In the following section, a summary of the findings of the study is presented with respect to each research question formulated at the start of the study.

7.2 SUMMARY OF FINDINGS

Three research questions were formulated at the beginning of the study and are stated below, along with a summary of the findings. This summary will optimally combine all the findings from the SPSS, Rasch, and thematic analyses.

Which learning strategies were reportedly used more frequently by students, and which were reportedly used less frequently?

Section 4.3 presented the findings on the most and least used learning strategies reported for the overall sample. The learning strategies of environment structuring, effort regulation, and elaboration were reportedly the most frequently used learning strategies by students. That is, the items that constitute these learning strategies were frequently reported to be used by most of the students. The opposite is true for critical thinking, task strategies, help seeking, and peer learning, where normalised mean scores were the lowest

indicating that most students did not endorse the items that constitute these learning strategies. Learning strategies of time management, rehearsal, organization, and metacognitive self-regulation were somewhat in the middle reported being used to some extent by most students.

Which learning strategies differentiated between the strongly performing and poorly performing students?

According to the SPSS statistical analysis, the learning strategies frequently reported to be used more by successful students than their unsuccessful counterparts were effort regulation, goal setting, and time management. That is, the ability to control effort and persevere when the work was difficult and uninteresting, the ability to develop an action plan and set goals, and the ability to schedule and use time effectively were all traits associated with strongly performing students. The Rasch analysis confirmed this, with DIF observed between students who passed and students who failed the exam for the learning strategies of effort regulation and goal setting, as well as to a lesser extent, time management. It was found that these learning strategies were endorsed more by students who passed the exam than by those who did not.

According to the SPSS analysis, peer learning and critical thinking learning strategies were significantly associated with low-performing students. According to the Rasch analysis, there was a significant DIF for critical thinking, which was found to be endorsed more by students who failed the exam than by those who passed. Peer learning and help seeking, on the other hand, demonstrated consistent misfit to the Rasch model, indicating the influence of other factors besides self-regulated learning were at play and hence were eliminated from the instrument. As a result, it was determined that critical thinking was thus the only learning strategy more associated with poorly performing students. We proposed that the items used to probe the use of critical thinking learning strategies were not well aligned with the type of critical thinking appropriate to first year chemistry course warranting further investigation.

How did online learning as a result of the lockdown restrictions affect students' use of learning strategies?

According to the statistical analysis in the SPSS, the learning strategies of peer learning, help seeking, and task strategies had low frequencies of positive response categories, indicating that most students did not respond with "mostly true of me" or "very true of me", these learning strategies were also found to be used more by low-performing students, which was unexpected. Furthermore, according to the Rasch analysis, peer learning and help seeking demonstrated consistent misfit to the Rasch model. These learning strategies showed erratic responses and underdiscrimination between less and more self-regulated students. This finding suggested that factors other than the ability to self-regulate were influencing students’ responses to peer learning and help seeking items, and this was investigated further by a follow-up survey. On the item map, task strategies were revealed to be the most difficult learning strategy to endorse. These learning strategies were further investigated using a follow-up survey to determine the impact that lockdown restrictions, as well as the shift to online learning, had on their use.

The follow-up qualitative investigation revealed that isolation because of the pandemic affected the use of peer learning. Students felt isolated from one another in the sense that they were unable to physically meet up with their peers and faced the challenge of internet connectivity so that they could meet with their peers using online platforms. It was also noted that some students merely preferred not to use peer learning as a learning strategy. Students elaborated, stating that they did not have the opportunity to form relationships and thus could not engage in peer learning. Students suggested that instructors create online formal social groups with a designated tutor to facilitate student interaction with one another. In terms of help seeking, students felt discouraged from using online platforms to seek help and resorted to addressing their confusion on their own using online sources and the textbook. In terms of task strategies, the students' main concern was fear of being exposed to others, that is, having their lack of knowledge or understanding exposed in a public setting because they had to use the discussion board to ask questions. Students proposed that the discussion board include an anonymous option for asking questions.

Although some students chose not to use these learning strategies, and others encountered difficulties in doing so, students highlighted how the use of these learning strategies could improve their learning. Students stated that using these learning tools could lead to a better understanding of content, particularly through peer learning, in which students would have to share and discuss ideas with their peers. It can be concluded that the lockdown restrictions, in conjunction with online learning, influenced how students used peer learning, help seeking, and task strategies.

7.3 IMPLICATIONS OF THE FINDINGS

Since this study investigated the use of SRL strategies by students with the goal of obtaining information that would inform future course design and guide students to become better self-regulated in their learning, the findings have two implications: implications for research and implications for instructors. The implications for research emerge from the findings of the study regarding how the methodology related to the results of the study and what should be improved and researched further. The implications for instructors derive from the findings of the SRL strategies reported by students and what this signifies for course design and structure.

7.3.1 Implications for research

The Rasch analysis revealed that the help seeking, and peer learning subscales had high residual correlations. This means that the items comprising the peer learning and help seeking subscales have more in common with one another than the other items. This was especially noticeable with items for help seeking that involved asking for help from a classmate, which appears to be the same as collaborating with a peer to work on schoolwork. This was undesirable because it suggested that the two subscales would work well if combined into one subscale rather than two subscales. This finding implies that more work is required in developing items for the two subscales that will work independently specifically for a context similar to the present study. Additionally, descriptive phrases were added to make the MSLQ peer learning items clearer

to the students, making the items suitable for online learning. As a result, it will be critical to revisit the peer learning and help seeking items and tailor them to the online learning context.

In this study, the critical thinking subscale also did not function as expected. When the critical thinking items were examined further, it became clear that they were inconsistent with the nature of the course. The items required students to challenge theories and ideas offered in the course, which is not what the first-year chemistry course requires. As a result, more research is required to investigate how to embed critical thinking into a first-year chemistry course, as well as what critical thinking items would be appropriate for a first-year chemistry course.

As previously stated in section 6.4, assessment feedback is crucial because it has been shown to improve learning by providing students with information that bridges the gap between their current and intended performance (Jug, Jiang, & Bean, 2019). Although feedback is one of the most important factors influencing academic achievement, the type of feedback, the time of feedback, and the way it is given can all have a varied impact (Hattie & Timperley, 2007). Students in this study proposed that the feedback they receive on their assessments be improved. The implications for research would be to investigate further how feedback may be related to SRL strategies and how both feedback and SRL strategies can impact on students' academic performance.

7.3.2 Implications for instructors

The findings of this study revealed that effort regulation, goal setting, and time management were associated with success in the exam in the sense that successful students reported using these learning strategies more than unsuccessful students. As a result, it is essential for instructors to encourage all students to use these learning strategies to improve the prospects of success for all students.

It was also found that students reported poor use of peer learning and help seeking learning strategies. The findings of the follow-up survey revealed that the constraints due to the pandemic contributed to the poor use of these learning strategies. As a result, it is important to investigate ways in which lecturers can incorporate peer learning and help seeking into fully online classes where students are unlikely to know each other. This can be accomplished through prompts in assessments, the formation of group tasks that encourage peer-to-peer interaction, and the provision of more safe channels that provide timely responses through which students can seek help.

The use of the discussion board that is incorporated into the task strategies was revealed to be problematic for the students as students indicated that they feared being exposed to others, that is, having their lack of knowledge or understanding exposed in a public setting as they posed questions, resulting in the reported poor use of the task strategies. It is therefore important for instructors to provide students with the option of posting their questions and comments anonymously or publicly.

7.4 CONTRIBUTIONS AND SIGNIFICANCE OF THE STUDY

Although some of the findings of this study cannot be generalized to other situations, they are nevertheless useful to the lecturers and tutors in the department of chemistry. The researcher strived to maintain the integrity of the qualitative data collected and was diligent when handling the quantitative data in order to evaluate the reliability of the survey tool and to produce trustworthy findings about the SRL strategies students reported using.

Components of the MSLQ (Pintrich, 1991) and the full OSLQ (Barnard, Lan, To, Paton, & Lai, 2009) questionnaires were used to collect data in this study. The findings on the utility of the two instruments add to the body of knowledge on their suitability in various learning environments. Learning strategies that distinguished between successful and unsuccessful students were identified. This information can then be used to tailor the learning opportunities in the chemistry module toward helping students to develop learning strategies that are more likely to lead to success. Furthermore, the findings may help to inform institutional support practices (such as student advising) to help students be more self-regulated and use effective learning strategies.

7.5 AREAS FOR FURTHER RESEARCH

The following areas for further research are proposed by the researcher:

- Data on students' reported use of learning strategies throughout the semester was collected near the end of the semester, and the findings were related to the students' exam performance. For future work, the predictive ability of the SRL strategies on exam performance could be investigated using data collected at the start of the semester to allow for early intervention to improve success rates.
- In this study, the items that comprise critical thinking were discovered to be inconsistent with the nature of the course. Critical thinking items that are consistent with the nature of the course and are specific to chemistry could be investigated for future work. Additionally, a qualitative study on the notion of critical thinking as it is used in the South African context would also be valuable.
- Explore the development of SRL strategies in chemistry modules ranging from first year to upper levels. This would reveal what SRL strategies remain useful and relevant as students' progress from one level of chemistry to the next.
- A comparison of the use of SRL strategies in different first-year chemistry streams, such as engineering chemistry, chemistry for medical students, mainstream natural science chemistry, and extended programme chemistry, would be another area for future research. This would help to understand the differences in pedagogical approaches and course design among the various chemistry streams.
- Students emphasized the importance of receiving timely and detailed feedback on their assessments for their learning. How receiving feedback on assessments impacts on the students use of SRL

strategies is another area for future work, as well as how both factors interact to influence academic achievement.

7.6 LIMITATIONS OF THE STUDY

Learning is contextual, that is, it is concerned with the behaviour of people and is hence not governed by strict laws, and it is influenced by a wide range of factors. As a result, the outcomes of this study cannot be extended to various learning settings. The research was conducted at only one institution of higher education, which limits the generalizability of the findings. It would be desirable to expand the study by bringing in students from other universities.

Because this study involves qualitative data personal experience of the researcher can influence conclusions. However, considering the focus of this research is on the learning strategies used in the module in which the researcher was enrolled during her undergraduate studies, personal experience may be useful in enhancing the findings.

7.7 CONCLUDING REMARKS

In closing this study, the researcher would like to put forward that the SRL strategies students use in first year shape not only their academic performance in first year, but also their academic performance in subsequent years of study, as students may carry those SRL strategies forward to higher levels of their studies. It is also important to note that the use of SRL strategies is dependent not only on the course, such as chemistry, mathematics, physics, or biology, but also on the circumstances under which learning occurs. As a result, when the circumstances surrounding learning change, students are more likely to adjust the SRL strategies they employ. For students who may fail to recognize the need to change the SRL strategies they employ, instructors must guide them in the direction of using SRL strategies that are relevant at the time. The researcher believes that it is critical for module instructors and coordinators to give themselves time to investigate and better understand the SRL strategies that students use on a yearly basis so that the course can be designed to promote success for all students but with a focus on the AR or LTP.

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APPENDIX A

STUDENT CONSENT FORM

My name is Langanani Rakhunwana, and this is my MSc research project aimed at identifying study habits that students use naturally that are effective for learning chemistry.

It is the intention of the study that the results should inform lecturers so that they can create learning environments that best support your education. Although there are no direct benefits to participants in this study, your participation may help you self-evaluate your best study approaches and become more effective in your own studies.

I am inviting you to participate in this research project because you are a CHM 181/CMY127 student. The procedure involves completing an electronic questionnaire that will take approximately 20 minutes. Your responses will be confidential, and you will remain anonymous when the results are reported. The information from the survey is used, in combination with Grade 12 and prior chemistry results, to look for average trends in the class and not data associated with individual students.

Your participation in this research study is voluntary. You may choose not to participate. If you decide to participate in this research project, you may withdraw at any time. If you decide not to participate in this study or if you withdraw from participating at any time, you will not be penalized.

If you have any questions about the research study, please contact Ms Langanani Rakhunwana on 0765059636 or email langirakhunwana@gmail.com

Please select your choice below.

Clicking on the "agree" button below indicates that:

• you have read the above information

• you voluntarily agree to participate

If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.

o Agree

o Disagree

QUESTIONNAIRE ITEMS (MSLQ and OSLQ) FOR MAIN STUDY

MSLQ

Rehearsal (Re)

1. When I study for this course, I practice saying the material to myself a number of times.
2. When studying for this course, I work through my lecture notes and the course materials a number of times.
3. I memorise key words to remind myself of important concepts in this course.
4. I make lists of important items for this course and memorize the lists.

Elaboration (El)

1. When I study for this course, I make use of information from different sources, such as lectures, course material, and discussions.
2. I try to relate ideas in this course to those in other courses whenever possible.
3. When studying for this course, I try to relate the material to what I already know.
4. When I study for this course, I write brief summaries of the main ideas from the textbook and my lecture notes.
5. I try to understand the material in this course by making connections between the course materials and the concepts from the lectures.
6. I try to apply ideas from course material in other course activities such as lectures and discussions.

Organisation (Or)

1. When I study for this course I make an outline of the material to help me organise my thoughts.
2. When I study for this course, I go through the content material and try to find the most important ideas.
3. I make simple charts, diagrams, or tables to help me organise course material.
4. When I study for this course, I go over my lecture notes and make an outline of important concepts.

Critical thinking (CT)

1. I find myself questioning things I hear or read in this course to decide if I find them convincing.
2. When a theory, interpretation, or conclusion is presented in the lecture or in the course materials, I try to decide if there is good supporting evidence.
3. I treat the course material as a starting point and try to develop my own ideas about it.
4. I try to play around with ideas of my own related to what I am learning in this course.
5. Whenever I find a claim or conclusion in this course, I think about possible alternatives.

Metacognitive self-regulation (M)

1. During lecture time I miss important points because I'm thinking of other things. (reverse coded)
2. When studying for this course, I make up questions to help focus my reading.
3. When I become confused about something I'm reading for this course, I go back and try to figure it out.
4. If course content is difficult to understand, I change the way I study the material.
5. Before I study new course material thoroughly, I page (or scroll) through it to see how it is organised.
6. I ask myself questions to make sure I understand the material I have been studying in this course.
7. I try to change the way I study in order to fit the course requirements.
8. I find that I study for this course but don't know what it is all about. (reverse coded)
9. I determine what I am supposed to learn from the material before I start studying.
10. When studying for this course I try to determine which concepts I don't understand well.
11. When I study for this course, I set goals for myself in order to direct my activities *in each study session*.
12. If I get confused taking notes in this course, I make sure I sort it out afterwards.

Effort regulation (ER)

1. I feel so lazy or bored when I study for this course that I give up before I finish what I planned to do. (reverse coded)
2. I work hard to do well in this course even if I don't like what we are doing.
3. When course work is difficult, I either give up or only study the easy parts. (reverse coded)
4. Even when course materials are boring and uninteresting, I manage to keep working until I finish.

Peer learning (PL)

1. When studying for this course, I try to explain the material to a classmate or friend (virtually or in person).
2. I try to work with other students from this course to complete the course assignments (virtually or in person) such as class, tutorial, and self-assessment exercises.
3. When studying for this course, I set aside time to discuss course material with other students from the class (virtually or in person).
4. I do not have anyone with whom I can discuss the material that I am learning in this course." (reverse coded)

OSLQ

Goal setting (GS)

1. I keep a high standard for my learning in this course.
2. I set goals to help me manage study time for my learning in this course.
3. I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester).
4. I set standards for my course assignments.
5. I don't compromise the quality of my work because it is online.

Task strategies (TS)

1. I use the discussion board to ask questions I have about the course content.
2. I read aloud instructional materials posted online to fight against distractions.
3. I try to take more thorough notes of the course content because notes are even more important for learning online than in a regular classroom.
4. I do extra problems in addition to the assigned ones to master the course content.
5. I prepare my questions before joining a virtual class discussion (Blackboard Live virtual lecture).

Time management (TM)

1. I allocate extra studying time for my course work because I know it is time-demanding.
2. I try to schedule the same time every day or every week to study for this course, and I observe the schedule.
3. I try to distribute my studying time for this course evenly across days.
4. I attend all my lectures for this course.

Environment structuring (ES)

1. I know where I can study most efficiently for this course.
2. I choose the location where I study to avoid too much distraction.
3. I find a comfortable place to study.
4. I choose a time with few distractions to study for this course.

Help seeking (HS)

1. I share my problems with my classmates online (WhatsApp, ClickUP, Facebook, etc.), so we know what we are struggling with and how to solve our problems.
2. If needed, I try to meet my classmates. (virtually or in person).
3. I am persistent in getting help from the instructor (lecturer or tutor) through the discussion board or in a live virtual lecture.
4. I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.

FOLLOW-UP SURVEY QUESTIONS

Study strategy: Peer learning

Working together with friends or classmates as a way of studying CMY 127

Questions (negative responders)

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)
2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?
3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

Questions (positive responders)

1. From the questionnaire, your responses indicated that you often worked with your friends/classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using this study habit. (You can list as many reasons as you want)
2. How useful was it for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?
3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

Study strategy: Task strategies

Using the discussion board or live virtual lectures to ask questions. Taking thorough notes. Doing extra tutorial problems than the assigned ones.

Questions (negative responders)

1. From the questionnaire, your responses indicated that you often did not use the discussion board or live virtual lectures to ask questions, or take thorough notes and do extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)
2. Out of the three study habits listed above, which one do you think would be the most useful for improving your learning in CMY 127 and why?
3. Which one out of the three would be the least useful for improving your learning in CMY 127? Please explain.
4. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

Questions (positive responders)

1. From the questionnaire, your responses indicated that you often used the discussion board or live virtual lectures to ask questions, took thorough notes and did extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using these study habits. (You can list as many reasons as you want)
2. Out of the three study habits listed above, which one did you find most useful for your learning in CMY 127 and why?
3. Which one out of the three did you find least useful for your learning in CMY 127? Please explain.
4. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

Study strategy: Help seeking

Asking for help from fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content

Questions (negative responders)

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)
2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?
3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?
4. Which one would be the least useful to you to seek help from? Please explain.
5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

Questions (positive responders)

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often sought help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using this study habit. (You can list as many reasons as you want)
2. Other than seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, are they any other places where you sought help from? If any, were they useful to you?
3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one did you find most useful to seek help from and why?
4. Which one was the least useful to you to seek help from? Please explain.
5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

ACCEPTANCE OF ETHICS COMMITTEE

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences
Ethics Committee

E-mail: ethics.nas@up.ac.za

30 July 2020

ETHICS SUBMISSION: LETTER OF APPROVAL

Ms L Rakhunwana
Department of Chemistry
Faculty of Natural and Agricultural Science
University of Pretoria

Reference number: NAS075/2020
Project title: Effective learning strategies for a blended first-year chemistry module

Dear Ms L Rakhunwana,

We are pleased to inform you that your submission conforms to the requirements of the Faculty of Natural and Agricultural Sciences Research Ethics committee.

Please note the following about your ethics approval:

- Please use your reference number (NAS075/2020) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, monitor the conduct of your research, or suspend or withdraw ethics approval.
- Please note that ethical approval is granted for the duration of the research (e.g. Honours studies: 1 year, Masters studies: two years, and PhD studies: three years) and should be extended when the approval period lapses.
- The digital archiving of data is a requirement of the University of Pretoria. The data should be accessible in the event of an enquiry or further analysis of the data.

Ethics approval is subject to the following:

- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.
- **Applications using Animals**: NAS ethics recommendation does not imply that AEC approval is granted. The application has been pre-screened and recommended for review by the AEC. Research may not proceed until AEC approval is granted.

Post approval submissions including application for ethics extension and amendments to the approved application should be submitted online via the Ethics work centre.

We wish you the best with your research.

Yours sincerely,

Chairperson: NAS Ethics Committee

APPENDIX B

PILOT STUDY RESULTS

This section presents the findings of a pilot study that was undertaken to determine the utility of the Online Self-regulated Learning Questionnaire (OSLQ) and the colloquial language used to ensure that it is appropriate for students in our setting. To avoid contamination of the main study sample, which was first-year chemistry students for BSc, the OSLQ was given to first-year engineering chemistry students. Only the findings of the reliability analysis and student comments on language use will be provided.

Aim

Prior to conducting the main study, a pilot study may help identify possible problem areas and deficiencies in the testing instruments and procedure (Malmqvist, Hellberg, Möllås, Rose, & Shevlin, 2019) and for this reason, a pilot study was conducted in preparation for the main study to assess a part of the data collection instrument thus to assess its utility and whether the terminology and language used were accessible to the students who participated in our study. That is, the key objective of conducting a pilot study was to determine if the OSLQ was useful and if the terminology and language used were understandable by the students who would participate in the main study. The Cronbach's alphas, also known as coefficient alphas, were calculated using SPSS. These values were then used to compare the reliability of the OSLQ to the original OSLQ from Barnard et al. (2009) to determine its utility.

Pilot study sample

Students enrolled in CHM 181 (engineering chemistry) were asked to take part in the pilot study. CHM 181 is delivered in the second semester of the year and is structured similar to CMY 127. These students were selected to avoid contaminating the intended sample for the main study. This selection of CHM 181 students as a pilot group was justified since the primary goal of the pilot study was to determine the usefulness of the research instrument, not to examine the learning strategies used. Only the OSLQ was given to the CHM 181 students. The MSLQ was not used in the pilot study as we had evidence to suggest it would be appropriate in our setting because it had been used in a previous study in the same institution by Kritzinger et al. (2018). The feedback from the pilot study was used to improve the OSLQ before it was used in combination with the MSLQ in the main study.

Reliability analysis

The pilot study had a sample of n = 80, and all questionnaires were completed with no missing responses. All OSLQ subscales were subjected to a Cronbach's analysis. The Cronbach alpha value for the questionnaire was determined to be 0.55, indicating that the instrument did not have an appropriate level of inter-item reliability. The table below shows the alpha values for each subscale.

Table B1: Cronbach's alpha values for OSLQ

Subscale	Cronbach's alpha
Goal setting	0.73
Task strategies	0.41
Time management	0.56
Environment structuring	0.64
Help seeking	0.54
Self-evaluation	0.40

Further investigation revealed that removing any of the items in environment structuring, goal setting, time management, or help seeking did not result in significantly higher Cronbach alpha values. However, removing item TS3 (I try to take more thorough notes of online course content because notes are even more important for learning online than in a regular classroom) from the task strategies subscale would raise the alpha value from 0.41 to 0.45. Finally, deleting item SE1 (I summarize my learning in online coursework to examine my understanding of what I have learned) from the self-evaluation subscale would boost the alpha value from 0.40 to 0.42, and deleting item SE3 (I ask myself a lot of questions about the course material when studying online coursework) would increase the alpha value from 0.40 to 0.47.

TableB2: Showing further reliability analysis for task strategies

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TS1	13.33	6.146	.172	.145	.384
TS2	12.84	5.606	.204	.072	.361
TS3	11.96	7.150	.071	.044	.445
TS4	12.49	5.418	.448	.222	.168
TS5	12.69	6.825	.181	.042	.373

Table B3: Showing further reliability analysis for self-evaluation

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
SE1	10.58	4.551	.125	.071	.420
SE2	11.31	3.053	.347	.317	.169
SE3	10.85	4.737	.062	.067	.473
SE4	11.18	3.184	.355	.303	.167

Comments from students regarding wording of the items.

1. "For question 20, it was slightly confusing to know what to answer with, as in none of the lectures do we see each other's faces, whether on Blackboard or on Google meet (for CIR lectures). I was unsure

of whether the question referred to face-timing/video-calling each other outside of classes, such as while doing homework and such, or where you were directly referring to during the classes themselves."

2. "…I don't quite understand question 3. When you say standard do you mean we keep a high standard of wanting to learn the way we would if we we're having contact classes? Or do you mean we expect ourselves to have a high standard of discipline and that we also expect a high standard of teaching from our lecturers/ tutors because it is online learning?"

This table shows OSLQ items as they appeared on the learning management system (Blackboard) for the pilot study

1. I use the discussion board to ask questions I have about the online course content [TS1]
2. I keep a high standard for my online learning. [GS1]
3. I share my problems with my classmates online (WhatsApp, ClickUP, Facebook, etc.), so we know what we are struggling with and how to solve our problems. [HS1]
4. I set goals to help me manage study time for my online learning [GS2]
5. I summarize my learning in online coursework to examine my understanding of what I have learned. [SE1]
6. I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester). [GS3]
7. I know where I can study most efficiently when learning online. [ES1]
8. I set standards for my online assignments [GS4]
9. I communicate with my classmates to find out what I am learning that is different from what they are learning [SE2]
10. I choose a time with few distractions for studying online course work. [ES4]
11. I allocate extra studying time for my online coursework because I know it is time-demanding. [TM1]
12. I read aloud instructional materials posted online to fight against distractions [TS2]
13. I try to schedule the same time every day or every week to study for my online course, and I observe the schedule. [TM2]
14. I try to take more thorough notes of online course content because notes are even more important for learning online than in a regular classroom [TS3]
15. I don't compromise the quality of my work because it is online. [GS5]
16. I choose the location where I study to avoid too much distraction. [ES2]
17. I do extra problems in addition to the assigned ones to master the course content when learning online [TS4]
18. I prepare my questions before joining a virtual class discussion (Blackboard Live virtual lecture). [TS5]
19. If needed, I try to meet my classmates face-to-face (in person or virtually). [HS2]
20. I ask myself a lot of questions about the course material when studying online coursework. [SE3]

21. I communicate with my classmates to find out how I am doing in my online learning. [SE4]
22. I try to distribute my studying time for this course evenly across days. [TM3]
23. I find a comfortable place to study. [ES3]
24. I am persistent in getting help from the instructor (lecturer or tutor) through e-mail. [HS3]
25. I find someone who is knowledgeable in course content so that I can consult with him or her when I need help. [HS4]

APPENDIX C

STATISTICS TABLES

T-test for exam performance

Table C1: Self-Regulated Learning Scores by examination performance.

Learning strategies	Exam performance	Mean	t-value	p-value	Cohen's *d*
Rehearsal	Fail Pass	10.96 10.53	1.67	.095	0.18
Elaboration	Fail Pass	17.68 17.74	-0.20	.846	-0.02
Organisation	Fail Pass	11.30 10.93	1.34	.181	0.14
Critical thinking	Fail Pass	11.80 10.72	**3.18**	**.002**	0.34
Metacognitive self-regulation	Fail Pass	33.54 33.56	-0.03	.978	-0.00
Effort regulation	Fail Pass	12.19 13.13	**-3.85**	**.000**	-0.41
Peer learning	Fail Pass	8.189 7.480	**2.37**	**.018**	0.25
Goal setting	Fail Pass	13.95 15.13	**-3.74**	**.000**	-0.40
Task strategies	Fail Pass	10.99 11.23	-0.86	.391	-0.09
Time management	Fail Pass	9.49 10.32	**-3.03**	**.003**	-0.32
Environment structuring	Fail Pass	12.81 13.25	-1.80	.072	-0.19
Help seeking	Fail Pass	8.495 8.039	1.50	.135	0.16

T-test for semester test 1

Table C2: Self-Regulated Learning Scores by semester test 1 performance.

Learning strategies	Semester test 1	Mean	t-value	p-value
Rehearsal	Fail	10.76	-0.40	.691
	Pass	10.87		
Elaboration	Fail	17.50	-0.82	.410
	Pass	17.78		
Organisation	Fail	11.16	-0.12	.907
	Pass	10.20		
Critical thinking	Fail	11.54	0.18	.856
	Pass	11.47		
Metacognitive self-regulation	Fail	33.27	-0.70	.482
	Pass	33.68		
Effort regulation	Fail	11.88	**-3.07**	**.002**
	Pass	12.67		
Peer learning	Fail	7.827	-0.64	.521
	Pass	8.028		
Goal setting	Fail	13.58	**-2.95**	**.003**
	Pass	14.56		
Task strategies	Fail	10.85	-0.99	.323
	Pass	11.14		
Time management	Fail	9.200	**-2.65**	**.008**
	Pass	9.956		
Environment structuring	Fail	12.62	-1.75	.081
	Pass	13.07		
Help seeking	Fail	8.255	-0.54	.591
	Pass	8.425		

T-test for semester test 2

Table C3: Self-Regulated Learning Scores by semester test 2 performance.

Learning strategies	Semester test 2	Mean	t-value	p-value
Rehearsal	Fail	10.85	0.10	.919
	Pass	10.83		
Elaboration	Fail	17.54	-1.16	.245
	Pass	17.88		
Organisation	Fail	11.32	1.11	.267
	Pass	11.04		
Critical thinking	Fail	11.72	1.49	.137
	Pass	11.25		
Metacognitive self-regulation	Fail	33.23	-1.38	.169
	Pass	33.93		
Effort regulation	Fail	11.91	**-5.16**	**.000**
	Pass	13.05		
Peer learning	Fail	7.986	0.07	.943
	Pass	7.967		
Goal setting	Fail	13.54	**-5.53**	**.000**
	Pass	15.11		
Task strategies	Fail	11.01	-0.47	.639
	Pass	11.13		
Time management	Fail	9.265	**-4.11**	**.000**
	Pass	10.28		
Environment structuring	Fail	12.66	**-2.76**	**.006**
	Pass	13.27		
Help seeking	Fail	8.470	0.66	.513
	Pass	8.289		

T-test for semester test 3

Table C4: Self-Regulated Learning Scores by semester test 3 performance.

Learning strategies	Semester test 2	Mean	t-value	p-value
Rehearsal	Fail	10.93	0.77	.441
	Pass	10.75		
Elaboration	Fail	17.73	0.25	.803
	Pass	17.65		
Organisation	Fail	11.33	1.10	.272
	Pass	11.06		
Critical thinking	Fail	11.74	1.63	.105
	Pass	11.24		
Metacognitive self-regulation	Fail	33.59	0.28	.782
	Pass	33.45		
Effort regulation	Fail	11.92	**-4.51**	**.000**
	Pass	12.93		
Peer learning	Fail	8.234	1.81	.071
	Pass	7.739		
Goal setting	Fail	13.72	**-3.60**	**.000**
	Pass	14.77		
Task strategies	Fail	10.92	-0.78	.438
	Pass	11.12		
Time management	Fail	9.411	**-2.41**	**.016**
	Pass	10.01		
Environment structuring	Fail	12.86	-0.67	.501
	Pass	13.01		
Help seeking	Fail	8.543	1.27	.205
	Pass	8.196		

ANOVA for performance subgroups

Table C5: Self-Regulated Learning Scores by Performance subgroups

Learning strategies	Subgroups	N	Mean	SD	F	Sig.	η^2
Rehearsal	AR	215	11.03	2.389	1.827	.162	0.009
	MM	169	10.82	2.385			
	LTP	40	10.25	2.619			
Elaboration	AR	216	17.79	3.141	0.118	.888	0.001
	MM	169	17.64	2.933			
	LTP	40	17.73	3.072			
Organisation	AR	216	11.38	2.490	1.229	.294	0.006
	MM	169	11.09	2.659			
	LTP	40	10.78	2.646			
Critical thinking	AR	215	11.85	3.268	**3.095**	**.046**	0.015
	MM	168	11.33	3.108			
	LTP	40	10.60	3.103			
Metacognitive self-regulation	AR	215	33.80	5.586	0.591	.554	0.003
	MM	169	33.24	4.800			
	LTP	40	33.85	5.186			
Effort regulation	AR	214	12.04	2.421	**11.20**	**.000**	0.051
	MM	169	12.68	2.180			
	LTP	40	13.80	1.977			
Peer learning	AR	216	8.333	2.893	**4.238**	**.015**	0.020
	MM	169	7.769	2.795			
	LTP	40	7.075	2.443			
Goal setting	AR	214	13.86	3.115	**9.744**	**.000**	0.044
	MM	169	14.46	2.870			
	LTP	40	16.08	2.645			
Task strategies	AR	215	11.01	2.699	0.065	.937	0.000
	MM	169	11.10	2.606			
	LTP	40	11.13	2.388			
Time management	AR	216	9.491	2.669	**3.786**	**.023**	0.018
	MM	169	9.911	2.551			
	LTP	40	10.65	2.413			
Environment structuring	AR	215	12.86	2.255	0.867	.421	0.004
	MM	169	12.98	2.430			
	LTP	40	13.38	2.047			
Help seeking	AR	216	8.685	2.915	2.180	.114	0.010
	MM	169	8.136	2.818			
	LTP	40	8.000	2.764			

APPENDIX D

FOLLOW-UP SURVEY WITH REPONSES

Peer learning (negative responders)

Candidate 1

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   So I have ADHD which makes it a lot harder for me to study and work in general and I need a certain controlled environment to work in as it takes me double the time to study a concept than normal students would take . I work my best alone as I struggle to study with others . the slightest thing can vause me to loose focus. I will however casually speak to my unit mate about it and discuss it a little .Also having to completely learn organic chemistry in English now takes a while longer making it harder to works with my classmates

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   In my case I don't believe there is a lot that can be changed in regards to this. It is extremely important for me that I have lecturers and tutors who can effectively explain the work in CMY127 abd give me enough examples so that I can grasp the concepts and study on my own.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   I don't mind working with classmates, but I do know that if I have to, it makes me less productive and I understand the work a lot less.

Candidate 2

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I didn't work with classmates because I really didn't know my classmates. Besides the fact that I already find it difficult to start conversations with people physically, online learning didn't do much justice to me getting to know my classmates more.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   I think it would be extremely helpful because this is a subject in which one mistake can mess everything that follows up, and so having classmates to help you spot these mistakes and errors and also getting to understand things from different perspectives allows for more learning and growth as sometimes the lecturers way of explaining a concept does not make as much sense as we'd like it to make in our brains.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

I think that having smaller online groups based on tutorial groups where questions can be asked and having our marks on time would help so that we know where we went wrong and have enough time to attempt to fix our mistakes.

Candidate 3

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I am 26 years old and busy with my second degree. I struggled to make a connection with some of the other students as I felt the age gap was too significant to form a strong bond. However, I think that it would have made it easier to connect with people if the pandemic did not cause campus closure, allowing students the opportunity to get comfortable with their surroundings and peers. I am part of a CMY 117 and CMY 127 WhatsApp group and found other students' queries helpful, but felt "stupid" to ask questions on the groups myself.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   I think working together with other students with CMY 127 would be extremely helpful as every person may have a different way of getting to understand the module content. If one individual struggles with a certain topic, it will most certainly be helpful to have a peer explain the content in a different way.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   This is a tricky question. I would probably say it would be a good idea to introduce students to a platform where they can interact, both in person and digitally. At the moment the WhatsApp groups come close to this sort of interaction platform, but I do think that allowing students to interact with each other in person will create a "safe" space where they can ask questions and get guidance from peers.

Candidate 4

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   The reason why I did not work with my classmates was that I honestly like working by myself and find it easier to understand the work when I do it myself, however I realized that this method of studying was not always effective and in future will try to work with others. My other reason was that I did not have the chance to make friends prior to the lockdown and thus couldn't network with other students and form study groups.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   I think that if I worked with other students I would have performed better than I did, because I would ask when I don't understand a concept and would get insight from someone who might understand the work.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   One of the major problems I personally had with the CMY127 department was that they took too long when marking assessments and this made it difficult to know where I stood throughout the semester. I would suggest that in future they try to give assessment feedback much faster.

Candidate 5

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   The main reason is that I didn't really get to know anyone else taking the module due to online learning and find it challenging to ask for help from people I don't know and since chemistry is a subject I tend to do well in I never really felt the need to reach out for help from classmates. Secondly I find, for me personally, I tend to develop a better understanding for a subject if I work on it on my own at my own pace.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   I think that there may be some sections of the work that I would find beneficial to discuss with other people and be challenged by them.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   Group projects/tutorials may be a good way to force people to work together. But I know that wouldn't be ideal since only a small part of the group end up doing most of the work.

Candidate 6

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I had tried to do a group study session in the past for CMY117 but I found that other study methods were a more efficient use of time. In general, for all my modules, I find that in group sessions I am either not able to grasp concepts I haven't already grasped or that it only aids me in reinforcing concepts I have already grasped when explaining to peers. For CMY 117 I achieved 82% for which I attribute the majority of my success to the OWL learning platform. Confidentially, I found myself making very little use of the lecture sessions and lecture notes. If there was a concept I was still not able to grasp, I would look it up on YouTube. I made use of the weekly tutorials to ensure I stayed on pace for the course's learning objectives. PHY131 made use of a similar platform (MGH Connect) for which I also found a lot of success where I achieved 90%.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   Reflecting on my performance of CMY127, I would have approached it with a different strategy such as perhaps working more with my peers. There are both academic and non-academic factors which

resulted in me underperforming in CMY127. I'm expecting, at most, a low 60%. I feel as if the organic chemistry of CMY127 was more theory-based than the analytical chemistry of CMY117/127 for which the OWL platform is used.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   I believe that implementing an organic-chemistry equivalent of OWL's analytical chemistry platform similar structure for organic would be greatly beneficial. CMY127 did have MGH Connect LS revision activities available which were optional to complete but I was a bit disappointed in how it was presented. I found that there was little congruence between the work being done in lectures and the MGHC activities. Specifically, there were was an overemphasis on the theory (and theory only in the second year syllabus) with very basic questions which did not test my understanding sufficiently. I found myself feeling overwhelmed by the mass of theory presented with no cue on how each concept related to the one before/after as well as what I needed to know/understand and, more importantly, be able to apply practically to the course.

Candidate 7

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I often did not work with others because I myself am uncertain about what I truly understand or what is it exactly that confuses me in this module. Everything is mixed up. Secondly, my peers seem equally as confused as me at times and I always have a distinct feeling that my questions are unwanted. Quite frankly, I seem to be on my own here regardless of how many people I know. I've reached out once or twice but the lack of enthusiasm combined with my introverted nature led to me studying on my own.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   If someone truly wanted to study with me and make plans together to better our studies than I would be all for it. It's very hard for me to study at home and having someone that wants the same thing as me will definitely better my performance.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?
   I believe that the module does not exactly encourage people to work together.. the notes don't give me much clarity or perhaps it's the fact that I understand better when someone explains rather than when I am reading or watching the lectures. In my opinion, I would be able perform much better if we had contact classes. During the pandemic, it has been very difficult to overcome this feeling of isolation and to focus on studies. Being a part of a class is a big part of the learning experience for me.

Candidate 8

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I personally did not work with other students, because I do not know a lot of people on campus. In the past I have also avoided working with other people or asking other people for help because they

normally think in a different way than me and this often confuses me. In the past I have helped some other students with questions but I tend to only ask for help from people who think like me or people who are experienced/know the work well enough to understand my way of thinking and approaching questions.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   I think that if I found people that shared my thinking and studying approach to chemistry or people with a slightly different way of thinking but understood my reasoning and methods that it would really help me get a better understanding of the work. Especially because I struggle to think further than the work being taught. I have found that other peoples questions in class increase my understanding of the work a lot.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   I feel that there is a need for more resources/opportunities for students to practice exam style questions, because I enter the semester tests and exams feeling like I know everything well, because I have worked through all the tutorials and class examples but then I score a bad mark on the tests. I think maybe working with other learners in smaller groups on exam style questions could be beneficial.

Candidate 9

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   In the CMY 127 module I did not work with my classmates as I work well alone or with people while face-to-face, but not over messages. I did not have enough data, nor a good enough connection to allow video calls to friends.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   Peer learning would be beneficial as it would allow me to learn while explaining and would make the study process more engaging and enjoyable.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   (no pandemic) students could use the tutorial sessions to work together. (pandemic) Whatsapp groups could be created for each tutorial group where questions and answers could be shared under the guidance of a tutor.

Candidate 10

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

I did not feel as though it was necessary to work with classmates. All troubles I had were easily resolved through simply reading the textbook or perhaps finding an alternative source on the internet.

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   I don't studying with classmates is the most productive way of achieving success in chemistry. The concepts we dealt with are all fairly straight forward and very rarely are difficult to comprehend. Most of the studying I found myself doing was simply memorization rather than conceptual building.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   The only request I could put forward is the release of answers to prescribed questions, it seemed rather silly that they weren't released

Candidate 11

1. From the questionnaire, your responses indicated that you often did not work with your classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   The pandemic made it impossible to study with friends. Before lockdown my friends and I tried peer learning once a week. However, that didn't work out well because there was always someone fooling around and not willing to work. For a module like CMY 127, you need to have friends that are of your intellectual level or higher. Otherwise your friends would be teaching you the wrong thing

2. How useful would it be for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   I think working together with classmates would be beneficial. However, only if they know what they are doing. I find that explaining a solution to a friend helps me to learn

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   I think the tutorial groups should be split into smaller groups. A group of students can then work together and then also have a tutor there to help if required.

Peer learning (negative responders)

Candidate 12

1. From the questionnaire, your responses indicated that you often worked with your friends/classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using this study habit. (You can list as many reasons as you want)

   Peer learning has been one of the most important methods of learning I have adopted, even before coming to the University of Pretoria. Having done majority (if not all) my pre-University schooling under the Cambridge Assessment International Education curriculum in Lesotho, we were taught Cambridge Learner Profiles, one of which included having the ability to work and collaborate with our peers for problem-solving, teamwork and the exchange of ideas and different perspectives on

the same topic. This ensured that us as learners would be able to understand syllabus themes not only from our own perspective but to also understand the same theme from a different perspective and stream of thought. Eventually, it became second nature to work in a team-oriented environment since it had been instilled into our learning regimen from the beginning of our school career. This also helps in appreciating other students' backgrounds, especially in multi-cultural environments as this teamwork ethos extends beyond schoolwork alone. When it comes to CMY 127 and peer learning, the foundation set by those Cambridge Learner attributes came in very handy.

2. How useful was it for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   Exchanging ideas with other CMY 127 students helped me understand concepts that would have left me confused without collaboration with other students who are doing the same module as I am doing. This reinforces the multiple perspectives method of acquiring knowledge that is multi-faceted and explored form all possible angles.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   With Covid-19 causing widespread disruption to contact learning, instant messaging and video conferencing became the norm - teamwork and group collaboration is still possible if we use tools we have at our disposal: WhatsApp group chats seem to be the most popular manner for me and other CMY 127 students to keep in touch with each other in order to share knowledge, discuss our different viewpoints and dispute and correct logical fallacies that may arise if Chemistry concepts are not throughly understood. Alternatives to WhatsApp include Zoom, Google Meet, Microsoft Teams and Skype to name a few.

Candidate 13

1. From the questionnaire, your responses indicated that you often worked with your friends/classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using this study habit. (You can list as many reasons as you want)

   When I say this, I mean that I tell my boyfriend about my work. He is studying Computer Engineering, which means that he doesn't have chemistry (other than high school) at all. By telling him about my work, it forces me to be very thorough when explaining a concept. It also allows me to hear the work, which is beneficial since I have an auditory learning style. Explaining the work to him also serves as additional revision

2. How useful was it for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   Very useful, see reasons in above question.

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   Honestly, I think it would have been better for me to attend face-to-face lectures rather than online lectures. It is more difficult to connect to friends online than it is in person or on campus. We were only at University for a month, which wasn't enough time for me to find people that I really connect with or that I can study with

Candidate 14

1. From the questionnaire, your responses indicated that you often worked with your friends/classmates to study chemistry in CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using this study habit. (You can list as many reasons as you want)

   I wouldn't say that I actively use it as a study technique, but rather as a method to strengthen my studying. I remember things better if I was able to interact with it. I can interact with lecturers, but the easiest way is to have friends/peers to learn from and interact with. So I place a lot of emphasis on discussing the work and helping other students. By helping others, I can see how well I know the work myself.

2. How useful was it for you to work together with your friends/classmates as a way of learning chemistry in CMY 127?

   It was really difficult to collaborate with other students during CMY 127 because we are all on our own schedules, meaning if i wanted to ask you something, it might take a while for you to get back to me, or you are busy so i end up just not asking, whereas in class i could have turned to my friend and asked the question. I really think it would have been much easier to get through CMY 127 if i was able to be on campus with friends in lectures

3. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to work your friends?

   I think under non-pandemic conditions, the module's teaching strategy was working, but once we went online, it fell apart a bit. We make use of tutorials to interact a lot. When the tutors are incompetent using technology it hinders our interaction with each other and the tutor. At one stage we had so much work from all our modules and CMY 127 that it was impossible for me to attend tutorials, so i just wouldn't make an effort to attend them. A place where i could learn the most, i was neglecting because i was being forced to do other test, assignments, etc. for CMY 127 but not the tutorial.

Help seeking (negative responders)

Candidate 15

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   The main reason why I did not seek help from others with regards to CMY 127 was mainly due to the fact of the online schooling. Since online schooling began I have not really had contact with my people that I knew from CMY 153 so the transition to CMY 127 was not very convenient in terms of making friends because now there were new learners that I did not know. So being in contact with lecturers was convenient either because now everyone would be trying to email the lecturers or tutors, then you would not be able to get an immediate response. Therefore I resorted to independent studying.

2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

I resorted to using YouTube to try and videos of some work that I did not understand or at times I would soldier on hope for the best. To some extent the YouTube video's were helpful but they were really time consuming.

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

   I believe that the YouTube videos were really the best at understanding the work because they work explained at in a generalized manner thus understanding was easier compared to how a lecturer would explain content in a more academic manner.

4. Which one would be the least useful to you to seek help from? Please explain.

   I feel like the lecturers and tutors were the least useful, and I am not blaming them I mean the pandemic has really forced us into some difficult circumstances. So I feel like most students were trying to get in contact with the lecturers and tutors, thus it made it harder for them to easily communicate with fellow students as it were on campus where you could have easily popped up for a brief session of consulting.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

   I believe that a way to better improve learning and understanding in CMY 127nis the introduction of pre and post quizzes at he end of lecturers. I noticed that in the modules where I had them they work was easier to understand thus at the same time it would be a benefit students to actually prepare for the lecture, so that during the lecture everyone can actually understand and also engage during lecturers.

Candidate 16

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I prefer to go through the text book and YouTube videos to try and figure out what I don't understand in my own way. I also found it easier to ask questions on campus in face to face lectures and tutorials.

2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

   I Often look to videos on YouTube that explain the content , I find that these videos very helpful.

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

   Tutors- The Tutor I had this year for my tutorials was very good and she explain the content in a way that was very easy to understand so I would ask her for help

4. Which one would be the least useful to you to seek help from? Please explain.

Fellow classmates- I feel that my classmates are learning the content at the same time as me and their knowledge isn't as reliable as a tutor or lecturer who has been dealing with the content for years. Also the likelihood of your question being ignored on a group chat with your peers is great ,this makes me feel that its not worth asking them.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

I'm really not sure

Candidate 17

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I did not ask for help mainly because I felt that I was so behind in my work and asking for help would require me to be knowledgeable of the basic terminologies and content of whichever theme. I feel as though I could not seek help because there was so much I did not know so even if I were to seek help and receive an answer from someone it would be useless/hopeless because I would not understand what was going on and most importantly why. I assume that if I were to receive an answer, the other person might answer thinking that basics would be obvious to us both. I know that in all of my modules if I need help with a question from a lecturer of tutor, I would need to send my working out first, and if I were to send my working out I feel as though it would be so pathetic because I do not even know what I do not know, I do not even know the basics so it would be useless. I would rather self-study and figure it out myself even though this takes longer.

2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

   I sought help from google. It was not helpful.

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

   Tutors would be the most helpful out of the 3 because they seem to have the least on their plate compared to lecturers and I would have a greater chance at getting the most correct response and most accurate help in less than 24 hours. The tutors are doing the tutorials and are doing the questions we are doing in extreme depth, they have more experience/years in CMY 127.

4. Which one would be the least useful to you to seek help from? Please explain.

   Classmates. I have greater chance of being misled, (even if they are repeating the module) because they are doing the same work as I am...Not to say that they are completely unreliable.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

   Pre-recorded lectures (for analytical chemistry since organic chemistry has pre-recorded lectures).

Candidate 18

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I struggle with social anxiety, and I find it very hard to talk to people especially to ask them questions if I don't know them or have at least some kind of relationship with them. With the online work it was very hard for me to build comfortable relationships with the lectures, tutors or my fellow students, although to be honest I don't know if it would have been better for me with contact classes. At least with the contact classes I would have sat next to or near someone who I could ask.

2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

   When I didn't understand something I usually:
   (i) *Looked through the notes on clickup to see if I missed something*
   (ii) *Then I would find the recorded lecture and see if the Professor says anything not on the notes*
   (iii) *Then I would find other online resources e.g. YouTube. How useful this was to me is hard to say, I didn't have a great semester mark for CMY127 and I also really struggled with the exam. I just want to add that I used the same study model for CMY117 and I achieved 79% for my final mark.*

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

   I would be most likely to seek help from the tutors- I feel like they are the least intimidating, and they are knowledgeable in CMY127.

4. Which one would be the least useful to you to seek help from? Please explain.

   I don't think that I would seek help from my classmates personally. I would maybe seek help from a group of students? I don't know it would depend. If I didn't know how to answer a certain question, I would probably post the question on a group but I would never ask them to explain a concept or chapter of the work to me.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

   I don't really know. I think the tutors that mark our practicals/tutorials/ tests should comment on our mistakes with a link to email if you done understand why you got the question wrong.

Candidate 19

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

The reason why I do not often seek help from fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127 is because when I encounter content that I do not understand my strategy is to look at tutorial recordings, look at answers for OWL assessments, and youtube videos. I would consider seeking help from other people as my last resort if the previous strategies do not work because I am afraid of bothering someone while they are busy. I feel quite fortunate enough that I have not yet felt the need to seek help from anyone.

2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

   The strategy that has helped me the most to understand my work is through rewatching tutorial recordings, The tutors explain the steps really well and also I like that there is a variety of questions that are being done during the tutorial session. Practicing old OWL assessments is also very helpful because after you attempt to answer the presented questions it gives you an in-depth memo explaining each step to solving the questions which helps improve my understanding of the work. I sometimes use youtube videos because sometimes the person in the youtube video explains the work in a way that helps me understand the work better.

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

   I think tutors would likely be the most useful to seek help from, because judging by how the tutors conduct the online tutorial sessions, they explain the work quite clearly, they are more knowledgable than my classmates and they appear less intimidating compared to the lecturers.

4. Which one would be the least useful to you to seek help from? Please explain.

   I would consider my classmates as the least useful to me because in my experience usually classmates don't explain as well compared to a tutor or a lecturer.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

   I think that the way CMY 127 is constructed is entirely fine, I cannot think of any way for it to make it easier for me to use this study habit. I am glad that if I ever felt the need to consult someone to help me understand the work such as a tutor or lecturer I could email them at almost any time.

Candidate 20

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   when I didn't seek help from lecturers, tutors, students. Firstly, it's mainly OK. I'm also I'm going to answer separately for analytical and organic, if that's fine, because to me they were just completely different things. So yes, analytical chemistry. The main reason I didn't ask for help is because If I didn't understand something, I couldn't pinpoint what I didn't understand. So I just felt like I didn't understand anything. And I looked at the whole section and I say to myself, I don't know what on earth is going on here. I don't know one thing that's going on here, even though I most probably did, it just didn't feel like it. I just felt I can't just go to the lecture and say I don't understand everything,

OK, what can I do? so I didn't consult anyone about that, but I felt like if I was feeling like that, if I didn't understand the whole section, then I would consult the textbook and just work through everything from start to finish just thoroughly myself. And then, while I was working through it then, as soon as I did something that I didn't understand, I could see, okay, I don't understand it. Let me just do it. Do it. OK, I'm getting it. And then I understand. And then I could just carry on. And then with organic chemistry, I honestly just felt organic chemistry was so much better for me. I understood so well and it was a lot of fun actually. I really, really enjoyed it. And there I could pinpoint what I didn't understand. But I don't want to brag, but it wasn't really much I didn't understand. I mean I was studying obviously. But I when I was going through lectures I understood everything. And there was one thing I didn't understand. It was the Fisher predictions had to convert Fisher to Heyworth. So I went back to the videos, the lecture videos.

2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

   Other places I sought help, I went to textbook - organic. And I just went back to the lecture videos for that.

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

   OK, which one out of the three will be the most useful? I think the tutors, because I really feel like the lectures are just too busy. And I were unnecessary. I felt like my questions, especially with analytical, seen as I didn't even know what were the right questions to be asking, I did not know what exactly would help me understand. I feel like I just didn't want to waste their time.

4. Which one would be the least useful to you to seek help from? Please explain.

   OK, so the least useful for me. I think it would actually be the students. Because with lecturers and tutors, they have years and years of experience, and this is just basic stuff for them. Therefore, they know exactly how to explain it, exactly what parts are important, what parts are less important. And some students would be able to explain it very well. But I feel like if if I went to students, I feel like some of them would be able to explain very well, but sometimes, maybe they wouldn't pinpoint the exact place that was important or exactly how best to help me. So I feel like the lecturers and tutors have a lot more experience with that. And, also, we were only in varsity for a maximum a month and a half, and I didn't really get to meet many people. I did meet some people in chemistry. But definitely the two I was closest to, I felt like they were way too busy for me to ask them questions. And second of all, other people, I felt like I didn't really know them well enough, so that's also why I didn't ask students.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

   OK, so pandemic on a pandemic, I think I really, really love the idea of an anonymous discussion board questions, so even yeah, when the pandemic's over and when you go back to normal 127, that maybe they could keep that discussion board open with the anonymous option because that just seems I never used it, but that just seems like a really. I lot of emailing Electra's and. Asking questions during the tutorials or going to fellow students, I think writing an anonymous thing, especially if you're just a bit concerned about whether you're on the right track at all and you just

don't want to be embarrassed about it. And I mean, other students can benefit from the discussion board.

Candidate 21

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I don't have any contacts of my classmates to ask for help from them. I often did not know how to phrase the questions I had to lecturers and our tutors.

2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

   I used YouTube videos, yes they were helpful.

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

   YouTube is the most useful to me as the content is simplified and more difficult examples are explained well.

4. Which one would be the least useful to you to seek help from? Please explain.

   Lecturers, refer you to the tutor most of the time and sometimes the tutors confuse me even more.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

   Include diversity in terms of multi lingual tutors(Vanac) as phrasing of questions may sometimes be difficult for students who don't have English as home language

Candidate 22

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often did not seek help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I think would mainly be because of the online environment this semester, because I feel like every time in the beginning when I used to send a question or something, I feel like they would not actually understand what I mean, like I couldn't for CMY, which is a very complicated subject. And if you really do not understand something, you need to be able to express yourself fully, which I feel I could never do through an e-mail or through a message or something like that. I never felt like it was actually helping me and the outside tutor, which I usually had well, you have extra things also switch over to online due to the Covid thing. So I also didn't use any tutors from outside of the universit. And fellow classmates, sometimes I would ask, but most of the time I think it's my personality that I do not actually trust anybody who's not knowledgeable enough. So I don't trust their fellow classmates most of the time to help me because I'm afraid that they would just help me

in a wrong manner and that I would fail to get out of that manner if they told me that I was the right way to do the question and then it was actually not the right way and then I would struggle to get out of that method. So I feel like I just have a bit of trust issues when it comes to asking fellow students.

2. Instead of seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, what are other places where you sought help from? If any, were they useful to you?

   Yes. And then with question number two, instead of seeking help from your fellow classmates, lecturers or tutors or anyone who may be knowledgeable. And what are the other places where you sought help? I'm a very factual person, so I would rather make sure that I read all of the lecture notes again very thoroughly. And I would also, if it still did not make any sense, I could still not get any examples. I would go to my to my textbook. And I would see if there's any examples of it or if there's any explanation otherwise, if I really struggled with something, I would Google it and I would watch YouTube videos. I know some people, because I saw it actually on the CMY 127, even when they gave us the lectures that before the Blackboard Collaborate lectures, I would sometimes upload a YouTube video which explained the content. And those videos mostly help me actually very much so. I made use of YouTube videos. If I really could not grasp the concept that helped me a lot.

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one would be the most useful to you to seek help from and why?

   And then question three, which is out of the three fellow classmates, lecturers or tutors, anyone or anyone else who may be knowledgeable and seeing what I want to see in which one would most be useful to seek help from and why? I would say probably between classmates and tutors like like I said, I don't actually trust classmates, but sometimes I have this one friend who has the same academic level that I have in CMY 127. And sometimes we just like when I know it's I'm doing work, which I'm struggling with, I would work out the questions on my own and then I would ask her if we could compare our methods. Like when I was studying for the test, I would ask if we're going to compare maybe our answers or questions or methods if we did not have a full memo to rely on, which helped me a lot, since if we both had the same answer and if we both had the same method, it helped me and reassured me. So I would think that would be a useful for me if I use that a bit more, if I maybe had a bit more close friends who I trusted with the work and everything and then also tutors. I don't actually like. Covid situation with the online questions, but I feel tutors are very quick to reply, and when you start saying something and they don't understand the question, I never feel awkward or anything to say I still don't understand. I feel more comfortable asking them. So that would be also more useful.

4. Which one would be the least useful to you to seek help from? Please explain.

   And then which one would be the least helpful? I would say lecture's, which is actually very weird since the lectures are the people who are the most knowledgeable in this subject. Sometimes I've seen the lectures take a bit of a while to respond. And when I'm busy with a question and I'm struggling with it at that moment, I want an answer at that moment. I don't want to send an email, move on to next questions and then in a couple of hours, I'll then recieve an answer and my mind is has moved on. and It's actually the same thing with tutors also. I've seen many lectures and tutors, make mistakes, not because they're not knowledgeable, but I think it's because they're so busy and everything. So it's difficult to keep track of everything and with all the questions and everything. So then it makes me, confused as well. So I never know if I should send an email, but I think it's more about the about the lectures, which I do not feel would be the most useful for me personally to send

an email to if I'm struggling, but I think if it was on campus, I would definitely first ask the lectures because I know with the lectures what type of answers they want in the semester exams.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

   And in question five, where you are looking at the way of chemistry, you want to save and be structured in the general pandemic or no pandemic. What do you think can be done to change, to make it easier for you to use the study, have it? I think the best way for me with this study habit will not be too much of help seeking but that there should be more continuous assessments since I think the best way for me to study is trial and error. So if I'm struggling and I get something wrong, like let's say two weekly quiz, and I get it wrong then I can go back to the questions and I see, OK, this is how I made this mistake. And then I'd try to figure it out on my own, how I made the mistake, why I made the mistake and what's the right move. But I think that at the end, the best way for me is to learn by myself through my errors and then correcting it than it is for me to quickly ask for help before I've even attempted the question or to quickly ask for help before I try to figure out on my own what was wrong. Like I feel I would better study from my faults if I tried to do it on my own, than just continuing and relying on other people, because in the end, it's your studies, your marks, and you're going to write the examination on your own. So it's better for you to know the work by yourself and feel confident that you are able to know what mistakes you made. And now by yourself, how do you fix it instead of just relying on lectures, duties and classmates to help you through it because they're not going to be doing the examinations.

Help seeking (positive responders)

Candidate 23

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often sought help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using this study habit. (You can list as many reasons as you want)

   Asking for help from someone else is much better they might teach me new methods of interpreting the questions, or maybe it might have been me all along (I might've been interpreting the content in the wrong way). When asking for help from someone else, there's always something new that's help coming out. So if I could I would encourage anyone to seek help from someone if the content starts to challenging them. And one other thing I've realised with asking for help (especially from fellow classmates), it helps me develop confidence and develops my teamwork skills.

2. Other than seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, are they any other places where you sought help from? If any, were they useful to you?

   Yes there is, I watch some videos on YouTube, but this method I don't prefer it that much because I don't feel that much engaged (I just watch someone doing the work

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one did you find most useful to seek help from and why?

   Honestly speaking both lecturers and tutors were really helpful, but if I had to choose the ones who helped me with understanding, I'd say it's the tutors because during the tutorial session they really explaining everything in greater depth and emphasizing more on what we should really really know by heart.

4. Which one was the least useful to you to seek help from? Please explain.

   Fellow classmates, because sometimes we are both struggling with the same concept. Even if we still try to do it together at the end of the day we still ended up going to the lecturers and tutors for help.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

   To me most things are okay, but a problem that I noticed with CMY is that sometimes it took longer to mark the scripts (which I understand because there's so many of us), but I think CMY should have more markers, just in case the workload is overwhelming.

Candidate 24

1. From the questionnaire, your responses indicated that when you came across content you could not understand you often sought help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using this study habit. (You can list as many reasons as you want)

   I cannot learn something that i don't understand, because it doesn't make sense. In order to understand, I have to ask. One of the hurdles i found hindered that process is: I would have something i don't understand, so I would check the notes, then i still don't understand. Now I have to recheck to make sure i didnt miss something, if i don't find anything, i need to ask a friend. So i ask a friend, they are busy so it takes long for them to respond. When they respond, they either don't know, or can't explain it so i understand. Now i need to try another friend. Same thing, they don't understand. Now i need to send the tutor or lecturer an email. This takes days sometimes and when i have multiple modules to do this for, it gets really frustrating. Sometimes i would just ask the lecturer straight to get an answer quickly, provided they respond quickly.

2. Other than seeking help from your fellow classmates, lecturers or tutors, or anyone who may be knowledgeable in the content of CMY 127, are they any other places where you sought help from? If any, were they useful to you?

   Not really, the only other place i could find good quality help other than the above mentioned, is Khanacademy. They are really good and completely free.

3. Out of the three (fellow classmates, lecturer or tutors and anyone else who may be knowledgeable in CMY 127), which one did you find most useful to seek help from and why?

   Lecturers or classmates

4. Which one was the least useful to you to seek help from? Please explain.

   Tutors, very often they didn't understand what we were finding difficult, and struggled to explain it to us.

5. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier for you to use this study habit?

Making more opportunities to ask questions during the Live virtual lectures.

Task strategies (negative responders)

Candidate 25

1. From the questionnaire, your responses indicated that you often did not use the discussion board or live virtual lectures to ask questions, or take thorough notes and do extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   They reason for not participating in discussion boards is that I have never really engaged with the modules I dont enjoy. Chemistry 127 is a big struggle for me and I try to focus on my understanding of the work by myself. Doing extra problems seems unhelpful when I'm trying to understand the work itself first.

2. Out of the three study habits listed above, which one do you think would be the most useful for improving your learning in CMY 127 and why?

   Though looking back doing the extra tutorial questions would have helped me but also stressed me out when I realised how confused the tutorial questions would make me.

3. Which one out of the three would be the least useful for improving your learning in CMY 127? Please explain.

   Least helpful would be the discussion board. I just didn't feel comfortable voicing my confusions when I didn't even really know how to properly ask the question

4. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

   The chemistry itself isn't bad, its the way they ask exam questions that really throw me off. I freak out during the exam when I don't understand how to approach the questions. One way could be to maybe for the lectures to have an exam prep lecture where they actually go through difficult questions and how to break it down.

Candidate 26

1. From the questionnaire, your responses indicated that you often did not use the discussion board or live virtual lectures to ask questions, or take thorough notes and do extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I never used the mentioned platforms because I struggled with the work but I never really understood what is was that I struggled with so asking a question would have most likely have been an irrelevant question or may be relevant but did not know how to ask the question to get my point across. What I did for this module was I printed out the slides/workbook that was provided and during the pre-recorded videos, I would add my own notes and just do the examples as Prof did them. THe collab sessions were either way to fast at going over examples or the other issue I had was that the additional examples were not given to us beforehand so for example to draw a reaction and then to fill in the answer while the lecturer is doing it was so rushed for time that I ended up missing half of them and confusing myself because half were right half were a complete mess so I did not know which were right or not. I also found that the collab sessions were sometimes just a repeat of the pre-recorded video that I had just watched. I find using a textbook online extremely difficult. I need

to physically have the book with me so I never used the textbook at all (I think I used it in the beginning for a brief time to get the content page headings because I was getting confused as the theme heading we had was like alkanes or alkenes but then there were reactions and all sorts of other things so I just wanted a clearer break down of the themes)

2. Out of the three study habits listed above, which one do you think would be the most useful for improving your learning in CMY 127 and why?

   Taking good notes is really useful because you are physically writing down the notes yourself so it becomes muscle memory. You can listen to recordings over and over and still not fully understand the work no matter how often you watch.

3. Which one out of the three would be the least useful for improving your learning in CMY 127? Please explain.

   Discussion board. THe discussion board serves the same purpose as email or asking in the collab sessions. With my other modules, if I was working and I had a question, I would either email the lecturer immediately or just take note of it and ask in the collab sessions. This way it is easier for the lecture to respond because speaking is easier than typing the answer.

4. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

   The CMY 127 content is very challenging and he lectures rush over the work, and I know this is varsity and all that but with such a challenging module, I feel as though the beginning themes needed to spend more time on. They really are the foundation of the CMY127 module and if you do not understand it, you have no clue what's happening in the module. Maybe if we had contact lectures, we would not have so many assignments that also had to be done so we could spend more time learning the work but I found that we had a lot of assignments for all modules so finding time to learn the work was difficult. From the 6 weeks of contact lectures I had in the beginning of the year, most of our tutorial/practical sessions included a test in the 3 hours whereas now, we have the 3 hour tutorial session but then we also had an assignment to complete after the tutorial session so we spent extra time to do the assignment (hope what I'm trying to say makes sense)

Candidate 27

1. From the questionnaire, your responses indicated that you often did not use the discussion board or live virtual lectures to ask questions, or take thorough notes and do extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   Something that largely contributed to taking notes and doing extra problems relates to poor management of prioritising work. I find that managing one's time in a first year biological science degree is difficult as there is a large body of work with little interconnectivity; it felt as thought lots of modules didn't build on knowledge or relate to one another, and one will not necessarily need all of these courses for second or third year. On the other hand, it is difficult to definitively say what courses I will take in future, so every course would seem to be of equal importance. This is more simple in something like computer science where you only study programming and mathematics modules, because the scope of the discipline is much smaller. Hence, one is placed in a difficult position of prioritising what work to do at a specific time. I could be wrong, and this could just be a consequence of poor planning and time management, but I do earnestly think that there is a problem here which is beyond CMY. Nevertheless, this often resorted to some effort in CMY 127 being

diverted to studying for other semester tests or prepping for practicals, with the promise that "I will do it later.", which didn't always follow through.

When it comes to asking questions in discussion boards and live virtual lectures, that often relates to a difficulty in asking questions, and almost a fear of it. It seems a weird concept for one to not know how to ask questions, but that does seem to be the case in every module. Revision sessions have been cancelled throughout the year in many modules because lecturers don't get any questions. from students. Hence, there is likely a deeper problem here. Some of it obviously relates to ego; asking a question and feeling stupid, or more of the time in my case I didn't want to ask a question because I feel like it is something I should know, and by asking the lecturers I am disrespecting them in a way. Hence I would often resolve to look for the answer on my own, be it through course work or online. Something else that made following live virtual lectures difficult to follow was the lecture structure for the organic chemistry specifically. It was extremely difficult to watch the recorded lecture, work through examples and make the live virtual lecture in time. I then took to watching the lectures the night before, working through examples for the first twenty minutes of the lecture time slot, then joining the live virtual lecture. But most days necessitated the former. However, this issue was most likely specific to pandemic conditions.

2. Out of the three study habits listed above, which one do you think would be the most useful for improving your learning in CMY 127 and why?

   Doing extra tutorial problems is the most effective means of bettering one's chemistry skills. One cannot learn chemistry or any other science through note taking, because science demands intuition. Whilst following recipes for problem solving might get you through, gaining an intuition; a deeper understanding of the physical mechanics that dictate how the chemistry operates is significantly more rewarding. The best way to do this is by working through examples and thereby inducing the deeper mechanics at play. Furthermore, working through problems and reaching a dead end is finding a limit to your understanding and that helps with finding questions to ask.

3. Which one out of the three would be the least useful for improving your learning in CMY 127? Please explain.

   Extensive note taking is not the way to go. Notes are for compiling information that cannot be intuitively understood, only remembered. This has its place in CMY in terms of learning catalysts in organic reactions as an example. But spending more time on these notes can't help you, unless you are compiling loads of questions to ask yourself. This is because writing things down and reading through notes only triggers recognition of the work, which can trick you into thinking that you understand it. Writing down questions and covering the answer forces you to think and test your understanding. This is difficult to do in chemistry though, as chemistry is heavily reliant on applying concepts to test questions

4. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

   One solution to the collaborate or discussion board issue could be anonymity. Allowing people to ask questions without having the question tied to their name. Furthermore, from my understanding, the clicker app has functionality that allows participants to message the lecturer during the lecture. This could also be used to greater effect. Asking yourself questions is the most effective way to learn something, which is why study guides are such a useful resource. Beyond those questions though, people seem to struggle. As rudimentary a skill it may seem to be, I think there needs to be more

intervention in teaching people how to formulate questions, which questions to ask, what platforms to use perhaps through a workshop of some sort.

Using lecture times to mostly work through examples made the lectures feel more like another tutorial. I understand that chemistry heavily revolves around calculations and application of concepts, but, in my personal capacity, I think that lecture time could be used otherwise. However, I do feel that most would disagree with this. Lecturing will be changed forever after this pandemic, and different people will respond in different ways, but there is one that I find the most rewarding. I have found Mr de Beer to be a most phenomenal lecturer from day one, because his focus is not entirely on working through example after example. His lecture structure is much like that, but he adds in little bits of history and application of the chemistry we are learning. While many see this as a waste of time, I find it inspiring and find it to develop a greater depth of understanding in the work. Using lecture time to inspire students and give a greater depth into a specific corner of the work could serve as a better way to motivate students to study and to study in the correct aim of learning the science. Again, this is a very personal, likely controversial opinion that would likely require lecturers to change their own styles. If that would mean them reducing the effectiveness of their work, I understand how this could be impractical.

Candidate 28

1. From the questionnaire, your responses indicated that you often did not use the discussion board or live virtual lectures to ask questions, or take thorough notes and do extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   Personally, I find that listening in the lectures and reading through the notes is enough for me. I think this is because my personal mode of study is to form logical links between concepts, that way if I see a question that I'm unsure of, I can rely on my logical understanding of the content to get me to an answer. This has been very effective for me, as my marks show. I do the tutorial questions that are assigned to us, for a little bit of practice, but I don't feel like I need much more than that.

2. Out of the three study habits listed above, which one do you think would be the most useful for improving your learning in CMY 127 and why?

   Certainly I think the best way for me to really hone my skills is the tutorial problems. If I find that I am struggling to get through a particular section in my usual way, I will usually do some of the assigned tut questions, and that normally brings me to an understanding of the content. I think this is because when you are presented with questions you don't yet understand, it forces you to use the resources available to you to make yourself understand; there is no cheating with this stuff.

3. Which one out of the three would be the least useful for improving your learning in CMY 127? Please explain.

   I don't really find that asking questions in the live virtual lectures is that useful for me, mainly because I'm not very good at phrasing useful questions on the fly like that. If I don't understand something I will take in as much as I can in the session, and then just use the lecture notes or textbook afterwards to figure it out myself. This has always worked for me.

4. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

Honestly, I like the way it's structured. If I were to change one thing, it would be to have the tutors give us a separate pack of "challenging" tutorial questions, because I like doing the challenging ones for exam prep and stuff, but usually I have to sift through the standard ones to find them, which can be less effective.

Candidate 29

1. From the questionnaire, your responses indicated that you often did not use the discussion board or live virtual lectures to ask questions, or take thorough notes and do extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on why that was the case. (You can list as many reasons as you want)

   I did not make use of the discussion boards as I did not feel that there were any specific problems a peer or tutorial could not help me with. I did not attend the Tutorials at their scheduled times as I sometimes felt it was very time consuming and an unproductive use of my time. But I still used the tutorials in another way. Before each semester test and exam paper I completed all the prescribed tutorial problems on my own and then used the memos to mark my answers when I saw I did not get the correct answer I would use the specific tutorial that contains the working of that equations and then watch the small snippet to see where I made my mistakes. I found this method as a much more productive method as I could determine what I wanted to watch and skip the questions I already knew how to do. I did not take notes as I felt the slides were already very thorough, however with organic chemistry I used to videos from Prof. Pilcher to add notes to my slides as these slides were very incomplete

2. Out of the three study habits listed above, which one do you think would be the most useful for improving your learning in CMY 127 and why?

   The most useful study habit is probably to take more thorough notes as this will help one to focus in class and not fall behind as easily.

3. Which one out of the three would be the least useful for improving your learning in CMY 127? Please explain.

   I think the discussion board is the least useful as no one wants to use such a public space to ask questions and because several of the questions are answered in certain tutorials or one's peers can help with the questions.

4. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

   I think CMY127 should definitely consider giving more thorough tutorial memos as this makes it much less time consuming to practice the tutorial questions. I found the Tutorial questions extremely helpful just before a test or the exam. And searching for the snippet of the questions you are struggling with can also be very time consuming as each tutorial did different questions.

Questions (positive responders)

Candidate 30

1. From the questionnaire, your responses indicated that you often used the discussion board or live virtual lectures to ask questions, took thorough notes and did extra tutorial problems to study chemistry in CMY 127. Reflecting back on the module, please elaborate on your reasoning behind using these study habits. (You can list as many reasons as you want)

Personally I have not used the discussion board but I think it is a good way of studying for this module. The reason I have not used the discussion board is that most questions I would like to have asked, had already been answered. During lectures I found it hard to ask questions because it feels like I am holding back the entire class. Instead, I would ask a friend or I would thoroughly read the textbook as well as additional resources. I found this much more helpful because I would learn a lot more things along the way. This is also where thorough notes play an important role. During the session, I prefer to take notes on whatever the lecturer emphasizes or warns us that are common mistakes. Also, I take notes on questions that have been asked by the lecturers or students instead of writing everything from the lecture slides. Personally, I used a lot of external resources to help me compile my notes namely: youtube, khan academy and Lumen chemistry. I felt that if I did not understand my own notes, I found the concept to be much harder and I struggled with the tutorial problems. Tutorial problems were really helpful when I started the topic. The textbook was the most helpful since it had questions for each section. Once I completed and understood those topics, I could move onto the combined questions. After a few weeks of doing tutorial problems, I would move onto past papers since they are on a much higher level.

2. Out of the three study habits listed above, which one did you find most useful for your learning in CMY 127 and why?

   The most useful is the tutorial problems. Those questions prepared me for the harder questions that would eventually arise. The tutorial problems indicated to me if I understood the main idea about the topic that I was doing. If I struggled with the tutorial problems, I would go back and read the textbook again. In my view, I felt that the tutorial problems helped with multiple choice questions.

3. Which one out of the three did you find least useful for your learning in CMY 127? Please explain.

   The discussion board was the least useful. It was hard to keep track of where the question was asked and, unlike an email, there was no notification to tell us that our question has been responded to. If we struggled with a certain topic, it was hard to pinpoint the exact place that we were getting confused. If we had multiple questions, the tutor would miss it or it was hard to follow the replies from them. The time taken to respond to the questions on the discussion board is much longer than simply sending an email

4. Looking at the way CMY 127 is structured, what do you think can be done or changed to make it easier to use any of these study habits?

   Further external resources should be added so that students can use these sources to make thorough notes. For live virtual lectures, the lecturers should maybe include 2 or 3 clicker type questions to ensure everyone understands the main idea. I found the clicker questions very helpful during organic chemistry and that made me wish there were questions for the third quarter of chemistry as well. Instead of using examples from the textbook, maybe use a question from the multiple choice type questions or even the longer type questions. The class tests also helped me throughout the year since it indicated to me if I understood the topic. The main topic that I struggled with (Buffers and titrations) had no class test. I had to solely rely on tutorial problems for that specific topic in order to understand it