University of Mpumalanga Students' Use of Moodle in Promoting Mathematics Self-Directed Learning

by

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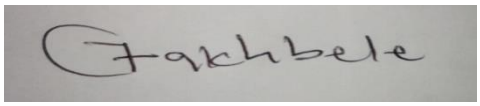
DECLARATION

I declare that this research report is my own original work. It is submitted for the degree of Doctor of Philosophy in the school of education (faculty of humanities) at the University of the Witwatersrand, Johannesburg. I confirm that this thesis has never been previously submitted for any other examination or in any other university.

I sincerely declare that this thesis is a product of my own work.



Yeyisani Evans Makhubele

14th day of JULY in the year 2023

DEDICATION

I dedicate this thesis to several people who have played a critical role throughout my life.

To my late grandmother, N'wanghilichi Thenjwasi Mathebula for raising me as your last-born son and making sure that I never missed my primary and high school classes. Your effort has finally been rewarded.

To my wife Irene, for being my greatest inspiration, my academic colleague and confidant. You have always remained my pillar of strength.

To my mom, Anna Thembi Mathebula, for providing spiritual guidance and support when days were dark.

To my beloved daughter, Lusanda. Wits has given me the edge, and I challenge you to follow daddy's footsteps

And to every person who has witnessed and supported my journey through the Ph.D. process, I will remain beholden to you.

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ABSTRACT

Research indicates that most students admitted at universities are underprepared in terms of self-directed learning. There is evidence that suggests that students who are not self-directed learners face a greater risk of failure when placed in the rich but complex environment of online learning. This mixed-method study investigates the students' experiences on Moodle in promoting mathematics self-directed learning (SDL). This study utilises an explanatory sequential mixed method design and a pragmatic paradigm for data collection. The study used four data sources, namely, the pre-evaluation questionnaires (150 participants), the post evaluation questionnaires (150 participants), the action logs and semi-structured interviews with six (N = 6) participants who were randomly selected. Two students were selected from one standard deviation of the mean, two from one standard deviation above the mean, and two from one standard deviation below the mean. This selection provided a varied reflection of the students' experiences than concentrating solely on the high or low end.

The study sought to answer the following research question: What relationship exists between Moodle Learning Management system and students' self-directed learning? And how do students use Moodle Learning Management system for self-directed learning? These research questions were underpinned by a specific set of research objectives. These research objectives were aimed at identifying the relationship that exists between Moodle Learning management system and students' self-directed learning, and also evaluating the readiness level of self-directed learning among first year students. This study utilises the Planned E-learning Interactions Framework. The quantitative data were analysed using descriptive statistics, and the qualitative data were analysed using thematic analysis.

The pre-evaluation questionnaire was used to measure the higher or lower readiness for students' SDL. 150 students completed this pre-evaluation questionnaire. The overall data analysis of the pre-evaluation questionnaire shows that the total mean for all the questions is 2.87, and the standard deviation is 0.88. The relative standard deviation (RSD) is therefore 2.9 ± 30.7%. This shows that the data is tightly clustered around the mean which is 2.9. The data is spread around the undecided score which is three.

The main findings from the pre-evaluation questionnaire indicate that the majority of first year students lacked the technological skills needed to manoeuvre the Moodle platform. Their self-directed learning skills were low, and they display a low positive attitude towards Moodle learning. A post-evaluation questionnaire was then administered to measure the higher or lower readiness for students' SDL after Moodle learning intervention strategies were implemented. 150 students completed this post-evaluation questionnaire. used. In terms of the post evaluation questionnaire, the overall data analysis shows that the total mean for all the questions is 4.43, and the standard deviation is 0.68. The relative standard deviation (RSD) is 4.3 ± 15.3%. This shows that the data is tightly clustered around the mean which is 4.3. The 15.3% shows more data is spread around four relative standard deviation which confirms that the participants' choices are closer to the mean, which is itself closer to the undecided score. The data shows that students have high self-management skills, high desire for mathematics learning and display high self-concept skills in their learning. Students therefore display high positive attitude towards Moodle teaching and learning.

The qualitative findings indicate that students have the capacity to take ownership of their learning in ways exemplified by self-directed learners. This study recommends that universities should invest a significant amount of energy and resources in orientation programs designed to assist first-year students in developing a sense of self as students and a sense of affiliation with their institution and course. With increasing use of information and communication technologies in education, students entering university need a basic level of computer proficiency to be able to access course material and complete assignments. Computer basic skills assist and encourage students to be self-directed, autonomous learners.

Keywords: Moodle, Self-directed learning, Learning Management Systems, online learning, independent learning, autonomous learning.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

CMS: Course Management System

DBE: Department of Basic Education

DHET: Department of Higher Education and Training

ICT: Information and Communication Technology

LMS: Learning Management Systems

MEP: Moodle E-learning Platform

Moodle: Modular Object-Oriented Dynamic Learning Environment

MSDLTS: Moodle Self-Directed Learning with Technology Scale

PRO-SDLS: Personal Responsibility Orientation-Self-Directed Learning Scale

SDL: Self-Directed Learning

SDLRS: Self-Directed Learning Readiness Scale

SRSSDL: Self-Rating Scale of Self-Directed Learning

SDLTS: Self-Directed Learning with Technology Scale

SPSS: Statistical Package for the Social Sciences

SPQ : Students Perception Questionnaire

TAM : Technology Acceptance Model

TDL: Teacher-Directed Learning

CHAPTER 1: CONTEXTUALISING THE STUDY

1. Introduction

1.1 Introduction and background to the study

Throughout their existence, universities have continued to rely on face-to-face learning to calibrate their program offerings. Recently, there has been a sudden transition to online learning. With the advent of online learning, students are no longer required to follow a planned, structured study schedule that is overseen and guided on campus; rather, they must develop greater levels of independence in their learning. This form of learning has fundamentally changed the university teaching and learning landscape. Du Toit-Brits (2020) asserts that this independent learning promotes students' initiative and independence, which is consistent with the self-directed learning concept (SDL). Several Learning Management Systems (LMS) are being used for teaching and learning as a result of the progression to online learning**.** One of the commonly used LMSs at institutions of higher learning is the Moodle (Badaru & Adu, 2022). The study by Badaru and Adu (2022, p. 75) found that "34% of South Africa's public universities use Moodle as their LMS".

Moodle has two distinct meanings. It stands for Modular Object-Oriented Dynamic Learning Environment first of all. Second, Moodle is conceived as a method for idly meandering through anything, doing things as they come to mind, and engaging in fun experimentation that frequently results in insight and creativity (Devi & Lakshmi 2020). A computer scientist and teacher named Martin Dougiamas developed Moodle after supporting a Course Management System (CMS) at an Australian university in Perth. He discovered that engineers, not teachers, had designed the CMS, which infuriated him. Martin came to the conclusion that an entirely superior system would have been created if it had been designed from the ground up using the educational process rather than the technical method. He began creating Moodle as an alternative by using his postgraduate degrees in computer science and education. Currently, universities, communities, schools, instructors, courses, teachers, and even corporations use this platform widely over the globe (Cabero-Almenara, Arancibia & Del Prete, 2019).

Moodle is described in a variety of ways by users. Moodle is described by Devi and Lakshmi (2020) as a method for delivering online courses and for enhancing conventional in-person courses. They define it as an interactive learning environment that makes it simple for

professors and students to share knowledge and build a group of students who are ready for the twenty-first century. Moodle is also described by Psycharis, Chalatzoglidis, and Kalogiannakis (2013) as a setting that enables the tutor to create crucial materials and activities that assist the students, in contrast to standard teaching approaches that may lead to ineffective learning. The researchers before them pointed out that traditional methods of instruction frequently include a passive transmission of knowledge from teacher to learner.

Moodle is a 21st-century LMS that supports blended learning and improves classroom instruction from lecturers. Moodle is therefore an e-learning management system that extensively enables blended learning because of the three characteristics listed below:

> …Usability: Moodle has a variety of useful options for students such as easy installation, customization of the options, security and management, easiness of navigation; software attractiveness and users' satisfaction (Katsamani *et al*., 2012).
>
> …Social presence: Moodle promotes a sense of community in online courses. Social presence is an essential aspect in any educational experience. This refers to participants' perception on others (other participants) as they view them as real speakers in mediated communication (Luo, Murray & Crompton, 2017).
>
> …Interaction: Moodle enhances student-student discussions (Acar & Kayaoglu, 2020).

Moodle is used as an LMS on the campus where this study was done. Moodle was created based on socio-constructivist pedagogy. In other words, it strives to offer a collection of resources that enable an online learning strategy centered on inquiry and discovery. This is a typical form of self-directed learning. Self-directed learning is linked to highly regarded characteristics including initiative, curiosity, self-reliance, capacity, and self-awareness (De Beer & Gravett, 2016). Students who engage in self-directed learning become intrinsically motivated to learn. They also point out that the key motivational factors arising from self-directed leaning include curiosity, interest, and internal need for self-improvement.

Moodle, an online learning management system, is meant to encourage independent learening. Higher education is in charge of giving students opportunity to develop scholarly capacity throughout their academic careers, claims Serevina (2018). This can be accomplished by giving students the tools they need through engaging and effective teaching and learning experiences.

These tools are not only for the classroom because they include solving real-world issues, which promotes the gradual growth of self-directed learning.

The university where this study was undertaken has adopted Moodle as its Information and Communication Technology (ICT) learning management system. The Moodle E-learning Platform (MEP) was selected because, when utilized properly, it can support SDL, a goal that is sometimes difficult for the majority of lecturers in undergraduate programs (Chang, & Lan, 2021). The focus of this study was therefore on Moodle and self-directed learning. All the university courses and modules where this study was conducted are offered through Moodle. The researcher's area of interest in terms of Moodle teaching was the students' perspectives on self-directed learning. The researcher investigated the students' perspectives on Moodle LMS in promoting mathematics self-directed learning.

Perspective is described as a way of thinking, particularly one that is impacted by the kind of person you are or by your experiences and viewpoints, in the Longman Dictionary of Current English (Longman Dictionary of Contemporary English, 2009). So, the term perspective refers to a specific way of viewing something, particularly one that is shaped by one's ideas and experiences. Hence, exploring different viewpoints was the focus of this research. Seeking perspectives is getting in touch with others to learn more about their perspectives on a given issue or circumstance. The purpose of this study was to comprehend students' perspectives on SDL. Finding fresh participants to think about and hearing from those who may have different points of view are what make perspective-seeking (as a skill) rich.

This study sought to examine how students perceived Moodle's role in encouraging self-directed learning. By default, a perspective is neither correct nor incorrect. That is exactly what it is: a person's perspective based on his or her experiences and values. In this study, perspectives were discussed within the context of Moodle, which is a digital LMS technology. The extent to which students believe themselves to be digitally literate and immersed in technology in their daily lives is taken into account from a digital technology perspective (Devi & Lakshmi 2020). Thus, in the context of this investigation, student perspectives would refer to their personal experiences and opinions regarding Moodle's role in fostering self-directed learning.

1.2 The empirical field

This study was conducted at the University of Mpumalanga in South Africa in the faculty of Agriculture and Natural Sciences. The students involved in this study were enrolled for the qualification of Diploma in plant production. The university has adopted Moodle as its online LMS. Lessons are, therefore, predominantly taught on Moodle. The e-learning policy framework for the university is consistent with the context of this study. Through supporting employees in the administration, creation, and delivery of e-learning, the university's e-learning strategy aims to raise the quality of staff and student learning experiences.

In South Africa, the vision for the implementation of ICT teaching and learning at universities is well articulated in the Department of Higher Education and Training (DHET) policy for the provision of distance education (DHET, 2014). The development of this policy has taken place in the context of the penetration and affordability of ICT across South Africa. The main goals of this policy statement are to improve distant education offerings at both public and private universities as well as other post-secondary institutions by fostering an atmosphere that is conducive to suitable ICT integration. In particular, the DHET wants to make sure that every post-secondary student has reasonable access to inexpensive connection through its policy.

The policy was developed on the technological needs and opportunities for South African institutions of higher education. Section 2.2 of the policy states the vision of utilising technology to encourage the participation of university students in the digital world. This policy aims at enhancing and increasing technology-supported learning. In accordance with this policy, technology-supported learning is defined as structured learning opportunities that are facilitated by software applications using digital resources (typically combinations of text, audio, and visual/video files) and accessed through a variety of fixed or portable hardware devices. Technology-supported learning can be synchronously delivered online (like real-time conferencing), asynchronously delivered online (like text-based discussion forums) or delivered offline (like interactive or resource-based CDs, DVDs, or flash drives).

The university where this study was conducted is aware that ICTs may be helpful in shifting education away from traditional methods and strategies and towards a more modern, accessible, and flexible learning environment. The flexibility and mobility of both formal and informal programs are improved with the use of ICT. The university tries to provide an

environment where its students can reach their potential and improve upon themselves. The university's mission is to be a leading African university in the creation of opportunities for sustainable development.

Excellence, integrity, diversity, collaboration, adaptability, relevance, and inspiration are some of the institution's core values. At the heart of the university vision is an academic community that is being empowered to be creative and take advantage of opportunities afforded by technology. This is done from the early stages of designing the course programmes. Also, the university has created an e-learning policy with the goal of enhancing students' learning experiences through the effective, imaginative, and confident use of technology.

This ICT-enhanced learning and teaching vision for the twenty-first century encourages the effective and efficient use of ICTs to broaden the scope and depth of academic offerings at the university. This vision is predicated on the assumption that the institution is aware of the potential benefits of ICTs in moving education away from outmoded approaches and methods and toward a more modern, accessible, responsive, and adaptable learning environment. ICTs are employed in this way to increase the mobility and adaptability of both official and informal programs. The core mission of the university in terms of e-learning is the education and training of students and the advancement, preservation, and dissemination of knowledge. At this university, excellence is cherished, pursued, and celebrated. The university is a socially and economically diverse community in one of the provinces of South Africa. Most students have no background knowledge on computing and e-learning. They receive basic Moodle training skills immediately after registration.

Studies showing that online learning may offer chances not present in conventional face-to-face teaching and learning forms served as the inspiration for this study. Students have options to personalize their learning and choose how and when to learn. Students can learn at their own pace, select which extra resources to use, and review course material as many times as necessary through online and blended learning before moving on to more advanced or difficult topics and information. Opportunities for formal and informal cooperation with other students, with or without faculty influence, is another benefit of online education (Doo, Bonk & Heeok, 2020).

1.3 The research problem

Several studies have shown that first-year students are not adequately prepared for the switch from in-person instruction to online instruction (Hill *et al*., 2020; van Broekhuizen, van der Berg & Hofmeyer, 2017; Luo, Murray and Crompton, 2017). These scholars contend that many students find it difficult to adapt to the self-directed learning environment found in universities. Particularly, they found that most students encounter difficulties navigating SDL activities. Many first-year university students from underprivileged neighbourhoods come from a setting where lecturers gave them summaries, handouts, and notes to use as study materials for their tests and examinations. These students expect lecturers at universities to furnish them with all the teaching and learning resources. According to research, "students find it difficult to adjust to the self-directed learning that is becoming more and more emphasized in universities" (Alharbi, 2018, p.232). Questions have also been expressed regarding higher education institutions' capacity to support students' independent learning (Zainuddin & Perera, 2018).

The majority of students accepted to universities are underprepared in terms of self-directed study, according to an overwhelming body of literature (Hill *et al*., 2020; van Broekhuizen, van der Berg & Hofmeyer, 2016; Luo, Murray & Crompton, 2017). In order to succeed at university, students must take ownership of their education, become more self-directed, and decide what to focus on and how much time to devote to it. The move from teacher-supported learning to SDL may be too challenging, especially for students who relied on their teachers for ongoing, parent-like assistance while in high school. According to Thomas and Brown (2011), one of the main issues facing higher education in the 21st century is that traditional methods of instruction and learning are outmoded and unable to keep up with the world's rapid pace of change.

Hence, self-directed learning is becoming increasingly important in higher education, where students are expected to be in charge of controlling their own learning. Sadly, research indicates that many first-year students do not learn independently, which makes the transfer to postsecondary education challenging (Hill *et al*., 2020, Mayhew *et al*, 2016; Van Zyl, Gravett, & De Bruin, 2012). What is expected of university students is not like this. Students are anticipated to be independent learners. SDL is now more pertinent because Moodle has been adopted as the LMS for all academic modules at the University of Mpumalanga. The purpose

of this study was therefore to investigate students' lack of self-directedness while studying. Thus, it is the main issue with this study.

The issue being investigated in this study is that empirical data indicates that "students who are not self-directed learners are more likely to struggle in the rich and challenging environment of online learning" (Uys & Citanda, 2020, p. 33). Questions concerning higher education's capacity to promote student autonomy have traditionally been voiced on a national level (Hill, Peters, Salvaggio, Vinnedge & Darden, 2020). Researchers have especially called for universities to promote learner autonomy (El Seesya, Sofar & Al-Battawi, 2017). Yet, recent research conducted in academic contexts have indicated that students at universities have not much improved their SDL skills (Hill, Peters, Salvaggio, Vinnedge & Darden, 2020).

Online learning and teaching have arrived at a time when recent reviews of undergraduate education in South Africa highlighted concerns about the under-preparedness of first year university students (Hill, *et al*., 2020; van Broekhuizen). These reviews highlighted concerns about the under-preparedness of students entering their first year and for the level of graduate competence upon completing their first degree. The transition that students must make between school and higher education seems to be particularly problematic. Some researchers identified the difference in teaching methods in high schools and institutions of higher learning as the main source of students' under-preparedness (Luo, Murray & Crompton, 2017). The teacher still serves as the main source of knowledge in most high schools. On the other hand, universities are now utilizing online education. Swart (2018, p. 20) argued that first year students' unpreparedness results from "a lack of self-directed learning on the part of students". Such unpreparedness and lack of self-directed learning is manifested in students' learning where students fail their first-year modules (Hill, Peters, Salvaggio, Vinnedge & Darden, 2020).

In this regard Luo, Murray and Crompton (2017) argued that one of the reasons why students fail their first-year modules is the fact that students coming to university from high schools are accustomed to traditional methods of learning where teachers ask students to recite and memorize the content of the study and what they teach in the classroom. When empirical data is closely analysed, it becomes clearer that the first year of study is a time of exceptionally high

drop-out rates due to a lack of self-directed learning (van Broekhuizen *et al.,* 2016). Studies show that one of the factors that contribute to first year students at universities lacking self-directed learning skills is that at high schools, students were taught through traditional methods which were teacher-centred, and exam driven (Credé & Niehorster, 2012; Mayhew *et al*, 2016). Such methods made students to solely depend on their teachers for their learning. In the teaching of Mathematics, these tend to promote rote learning.

University education expects students to be self-directed. This problem is compounded by the adoption of online education systems by most universities. Today, ICT is penetrating classrooms around the world at an extraordinarily rapid pace. As this penetration continues, teachers face increasing challenges as they teach a much more wireless generation of students (Millham, Thakur & Malan, 2014). The majority of South African universities are switching from conventional pedagogy to online teaching and learning. What is problematic is that the university where this research is conducted admits students from previously disadvantaged communities. These students are expected to be capable of learning online and possess information technology literacy skills. Among other things, information technology literacy abilities entail using technology as a tool for information gathering, management, evaluation, and communication. Most students at this university do not possess these skills considering that they come from disadvantaged backgrounds. These students were taught in traditional teaching methods yet will be facing 21st century contemporary teaching methods. Also, research indicates that some lecturers still use the traditional methods at universities (Hill *et al*., 2020).

The challenge for university lecturers is to shift the paradigm of teaching to integrate SDL into their teaching. This challenge is often complicated by the fact that first year university students may resist taking more responsibility for their learning because it may not make sense to them as they were used to a system where they were bombarded with continuous study material as a way of support by their high school teachers. Tomas *et al*. (2019) argued that students' lack of self-directedness is largely caused by students' unpreparedness for university because of the way they were taught in high schools. The Department of Higher education in South Africa is aware of these challenges. The Education White Paper 3 of South Africa was an attempt to address these challenges (DHET, 2012). This white paper states:

> …The higher education system is required to respond comprehensively to the articulation gap between learners' school attainment and the intellectual demands of higher education programmes. It will be necessary to accelerate the provision of bridging and access programmes within further education (DHET, 2012).

The main reason this institution chose Moodle as its learning management system is because it requires students to take responsibility for their own education. SDL is a crucial 21st-century skill that helps students acquire the knowledge and abilities required for this era. SDL became a critically important skill in recent years because of the change in the education system brought by the massive and escalating proliferation of information and technology. In current times of fast change, the individual learner must be the primary driver for assessing his/her learning needs, identifying learning materials, implementing and logically evaluating the learning.

The reality is that the students' lives are daily surrounded and enhanced by internet technologies. There is therefore a need for alternative and more effective teaching methods to be used (Cabero-Almenara, Arancibia & Del Prete, 2019). This is the rationale behind the introduction of Moodle at the institution where this study was carried out. The challenge is that most of these students were taught in traditional classroom environments using traditional methods of teaching. But modern instruction demands that students be proficient in computer and elearning skills. It is assumed that students will manage their own education at their own speed. As a result, the emphasis of student learning in the classroom has changed. The emphasis is now on learning how to learn rather than memorizing and retaining knowledge.

The next section introduces the purpose of this study.

1.4 The purpose of the study

This study sought to understand more about how Moodle promoted self-directed learning from the perspectives of the students. Hence, its objective was to evaluate first-year students' level of preparation for self-directed learning. The purpose of this research was therefore to determine whether self-directedness traits will manifest in students exposed to Moodle instruction. Living without online teaching and learning is unthinkable in the 21st century as it is right now.

The development of students' abilities to learn independently has taken the lead among academic objectives in higher university curricula. This is in line with the movement away from teacher-driven instruction toward learner-centered instruction, which aims to involve the students in the process of developing their knowledge (Ramstedt *et al*., 2016).

Universities want their students to be independent, self-directed learners. SDL gives students ownership over the planning, carrying out, and reviewing of many components of their learning process, according to Morris and Rohs (2021). Voskampa *et al*. (2020), who refer to this transformation as the biggest effort of the 21st century, have also pushed this viewpoint. Therefore, it was crucial to conduct this study because institutions of higher learning must embrace online and SDL competences in order to comprehend digital pedagogy and related technologies (Adinda & Mohib, 2020).

1.5 The research questions

This study sought to determine the SDL preparedness level of first-year university students. This study therefore explicitly sought to answer the following main research question: What relationship exists between Moodle Learning Management system and students' self-directed learning? In order to get clarity on the main research question, the following sub questions were proposed:

1. How do students use Moodle Learning Management system for self-directed learning?
2. To what extent do students perceive themselves to have the necessary skills to use Moodle for self-directed learning?
3. After using Moodle, how do students perceive the improvement of their self-directed skills?
4. How do students perceive the usefulness, effectiveness, and ease of use of Moodle?

1.6 The significance of this study and contribution to knowledge

This study might add to the corpus of knowledge regarding Self-Directed Learning Theory. In light of the aforementioned discussions, the goal of this study was to create a Moodle Self Directed Learning Theory (MSDLT) that will hopefully encourage students in higher education

to pursue their own learning. This Moodle Self Directed Learning Theory (MSDLT) is intended to support mathematics teaching and learning that is self-directed. In order to promote self-directed teaching and learning, a general Moodle Self Directed Learning Theory (MSDLT) will be developed using the findings. For this study, it is crucial that the theory that will be developed be relevant. The theory is intended to help the university's approach to Moodle-based, self-directed mathematics teaching and learning undergo a paradigm change. It is hoped that this study's findings would provide several Moodle pedagogical integration strategies that can be used to encourage self-directed learning in South African schools and universities.

For policymakers, academics, and university instructors, it is anticipated that this study will offer recommendations for future decision-making on the development of learner-centered and self-directed training. This study also aims to offer a methodological direction for the development of self-directed instructional design as part of creating the knowledge base for instructional design and development.

This study has the potential to bridge the digital divide in universities. The digital divide in education is the gap between those with sufficient knowledge of and access to technology and those without. According to Makonye (2017), bridging the digital divide will help to unlock the students' ICT potential and enhance their ICT competencies.

The findings will hopefully enhance students' Moodle learning instructional strategies by providing actionable skills that will eventually help to promote and develop Moodle mathematics self-directed learning. The information will also be used to guide professional development programs that can support effective learning through self-directed learning. Knowledge gained from this study can guide educational policy and contribute to better teaching.

Our knowledge of how to employ technology in education will also increase as a result of this study. The results will be utilized to improve the technical aspects of mathematics instruction and will motivate lecturers to use Moodle and other ICT LMSs more frequently. It will assist in overcoming the difficulties encountered while attempting to include ICT into mathematics teaching programs. ICT has evolved into one of the fundamental pillars of contemporary society. Understanding ICT is increasingly regarded in many nations as being essential to education. ICT is a vital instrument that lecturers can utilize to impart important and powerful mathematical ideas (Sang, Valcke, van Braak and Tondeur, 2010). This makes it possible for students to understand the concepts clearly and apply them to problem-solving. The findings

will therefore hopefully enhance lecturers' instructional practices by providing actionable skills that will eventually help to promote and develop Moodle mathematics self-discovery learning theory. The information will also be used to guide professional development programs on how lecturers and teachers can support effective learning through self-directed learning.

The findings might indicate how self-directed discovery learning and Moodle instruction relate to one another. They may prompt lecturers' and instructors' critical reflection, which will lead to action to address issues with ICT teaching and self-directed discovery learning. The findings might also act as a model for potential preservice and in-service courses on ICT teaching and learning. Education must adapt to the fast-changing world by educating students for the society in which they will work and live (Williamson & Seewoodhary, 2017). Technology is an external force that propels change in many aspects of our life, including how we work, learn, and conduct research. The inclusion of ICT approaches into the learning environment is now one of the most crucial elements due to the rapid advancement of science and technology.

It was important to carry out this study because we are now living in the digital mediated society. Online teaching and learning must embrace technology. Online teaching and learning must therefore replace traditional teaching and learning. Du, Fu, Zhao, Liu and Liu, (2013) argues that:

> …the use of ICTs provides the opportunity to transform traditional methodologies and approaches into flexible learning systems that could potentially address the needs of a more heterogeneous student cohort, widen access to universities to make higher education less exclusive, enable a paradigm shift in terms of pedagogical frameworks to not only use ICT as add-on or electronic replication of existing practice, provide continuous lecturer support, and impact on the type of physical learning environments within higher education institutions.

Online education is becoming more significant in all areas of education as governments and institutions work to use the advantages of technology (OER Africa, 2014). The benefits of e-learning over traditional learning are immediately obvious since it creates new opportunities for adopting pedagogical innovations in a setting where students are expected to participate actively, independently, reflectively, and collaboratively. This is a form of self-directed discovery learning. Self-directed discovery learning is the dominant form of lifelong learning. Lifelong learning is a necessity rather than a possibility or a luxury to be considered (Hill, *et al*., 2020).

1.7 Organisation of the study

This study adopted a 7-step research process which is summarised in the figure 1.1:

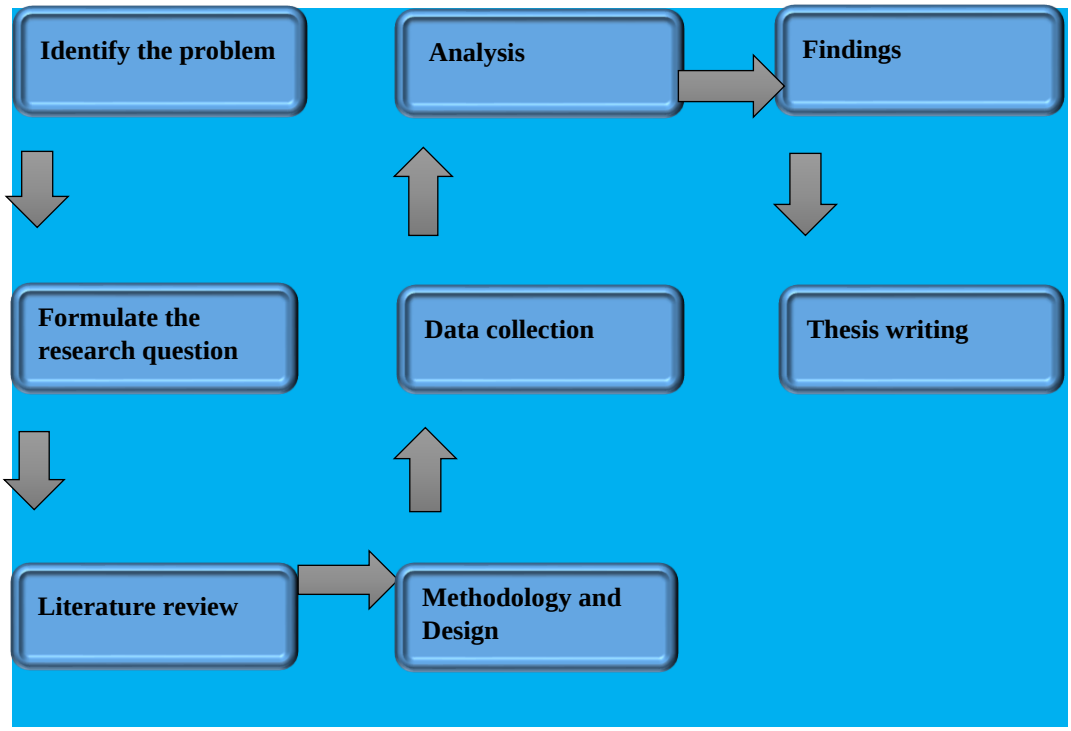


Figure 1.1: The study's 7-step research process: A visual representation of the whole research process.

This study is organised into seven chapters arranged thematically. Each chapter deals with a particular aspect of the report.

This chapter contextualises the study. It provides a broad introduction and context to the study. Also, this chapter includes a summary of the study's objectives and research questions.

Chapter two is concerned with the theoretical framework that guided this study.

Chapter three provides a review of the relevant literature related to this study. In this chapter, literature related to Moodle and self-directed learning is reviewed, including relevant research in these areas. In addition, the conceptual framework guiding the study is also presented in chapter two.

Chapter four deals principally with methodological issues related to the conduct of the study. The research paradigm employed, research methods and instruments used to collect data as well as the way those data were analysed are also discussed in this chapter. This is also the chapter in which such issues as the validity and reliability of the study and ethical issues for the study are dealt with.

In Chapter five, the presentation and analysis of data is done. The data from pre-evaluation questionnaires, post evaluation questionnaires, action logs and interviews are aggregated and discussed.

Chapter six discusses the findings in detail.

Conclusions and relevant recommendations based on the findings of the study are presented in chapter seven.

The final part of this report consists of a number of appendices. These appendices contain some documents related to this study. These include questionnaires and interview protocols used in the study, consent forms for the participants in the study, authorisation letters from the institutions where this study took place, as well as an ethical clearance letter from the University of the Witwatersrand.

1.8 Chapter conclusion

This introductory chapter was intended to set the scene for the study. Its objective was to provide useful information about the context within which this study was conducted. It also provided information about the research problem of this study. The research questions that guided this study also formed an important aspect of this chapter. The purpose of the study, its significance and contribution to knowledge were also discussed in this chapter. The last section of this chapter, section 1.7, presented the organisational structure of this study.

The next chapter presents the theoretical framework that guided this study.

CHAPTER 2: THE THEORETICAL FRAMEWORK THAT GUIDED THIS STUDY

2.1 Introduction

The theoretical framework that underpinned this study is covered in this chapter. First, the main learning theories and the study's perspective are discussed. The theoretical foundation for this study is then presented. A learning theory is conceptualised as a collection of assertions, tenets, or concepts that pertain to a specific subject and are intended to clarify and aid in our understanding of how people learn (Graham, Henrie & Gibbons, 2013). The goal of a theory is to put forth solutions to fundamental issues about a phenomenon. Steffens (2015) defines a theoretical framework as:

> … a collection of interrelated concepts which guide the research, determining what things the researcher will investigate and how he/she will analyze and interpret data, and as a theory that undergirds the researcher's thinking with regards to how he/she understands and plans to research his/her topic, as well as the concepts and definitions from that theory that are relevant to your topic.

Researchers utilise theoretical frameworks to better evaluate historical events by offering a specific set of questions to ask and a certain perspective to apply when investigating a research topic. A theoretical framework provides a specific perspective, or lens, through which to examine a topic. As a result, a theoretical framework is one of the most crucial and essential components of the research plan since it offers a context within which the subject being studied can be comprehended (Mensah, Agyemang, Acquah, Babah & Dontoh, 2020).

The focus of this study is on Moodle and self-directed learning. For this reason, this study will first discuss the philosophical framework upon which it is based. A link between the philosophical framework, Moodle and self-directed learning will be discussed. Secondly the theoretical framework that guided this study, The Planned eLearning Interactions Framework will be discussed in detail. The focus will be on the relationship between this framework, Moodle, and self-directed learning.

The emergence of Moodle has an educational background (Cabero-Almenara, Arancibia & Del Prete, 2019). In light of this, various learning theories have been used in the development of this LMS. In this chapter, the three major theories associated with learning, namely behaviourism, constructivism, and situated learning are therefore discussed.

2.2 The main learning theories

The main categories under which learning theories fall are behaviourism, constructivism and situated learning.

2.2.1 Behaviourism

The focus of behaviourism, as its name suggests, is on human behaviour. The development of behaviourism is frequently associated with Pavlov (1927), known for his studies with dogs, food, and aural cues like a bell, is generally credited with the development of behaviourism. The dogs' feeding-related noises were the subject of these tests. After a while, the dogs started to salivate as they started to associate the sound of the bell with the time for food or feeding. Classical conditioning was the term used to describe this idea of stimulus (the sound) and response (the salivating). These ideas of stimulus and response are the foundation of behaviourism theory. According to behaviourists, human behaviour would also follow a similar pattern. Repetition of a certain response to a stimulus strengthens the connection between them, which paves the way for the emergence of new behaviours.

Behaviourism in education looks at how students act when they are learning. Behaviourism, in more detail, focuses on how students react to certain stimuli that, when repeated, may be evaluated, measured, and finally controlled for everyone. In behaviourism, the focus is on what can be seen, not on the mind or the brain's cognitive functions. Hence, behaviourism solely concentrates on the modifications to behaviour that can be measured and observed objectively. These modifications are gained through conditioning and repeated until they become automatic. In sum, if something cannot be observed, then it cannot be studied. Behaviourism contends that "environmental factors influence how people learn new things" (Ertmer & Newby, 2013, p. 55). In behaviourism, teachers stimulate their students' learning by introducing them to ideas that are meant to help them learn more deeply. The instructor arranges the course contents in a logical order to facilitate learning (Mödritscher, 2006).

There are three learning-related presumptions made by behaviourism:

> …Observable behaviour is more important than understanding internal activities, behaviour should be focused on simple elements: specific stimuli and responses, learning is about behaviour change (Gredler, 2001).

Dunlosky *et al*., (2013) identified the following common behavioural approaches to learning:

> …The learner takes on a predominantly passive and reactive role, instruction is structured and systematic, goals, objectives and strategies aimed at learners in general and not on the individual learner, learning can be measured, focus is on simplification (start with easy and progress to more difficult) and repetition (rote learning / drill and practice), and instruction is instructor-controlled.

The behaviourist school sees the mind as a black box in which a response to a stimulus may be statistically observed, disregarding the significance of mental processes occurring within. As a result, this school considers outward behaviours that are easy to see and quantify as learning markers. This has some implications for online learning, namely:

> … learners should be informed of the clear learning objectives so they can establish expectations and determine for themselves whether they have attained the goal of the online course, learners must be tested to determine whether they have achieved the learning outcome. Online testing or other forms of testing and assessment should be integrated into the learning sequence to check individual learner's achievement level and provide appropriate feedback, the learning materials must be sequenced appropriately to promote learning. The sequencing could take the form of simple to complex, known to unknown, and knowledge to application, learners must be provided with feedback so that they can monitor how they are doing and take corrective action if required (Good & Brophy, 1990).

In behaviourism, teachers stimulate their students' learning by introducing them to ideas that are meant to help them learn more deeply each time. The instructor arranges the course contents in a logical order to facilitate learning (Mödritscher, 2006).

The behaviourist theory is explored in this study because it has provided useful insights for teaching, training, and learning in education as well as informed many disciplines on strategies of influencing behaviour (Kaplan, 2018). Principles of behaviourism have frequently been used in online education. Online software programs, for instance, give students quick feedback depending on their success, encouraging their progress in the subject matter. Drill and practice are used in behaviourist methods in practice, and specific feedback and instructions are encouraged (Alzaghoul, 2012). Education has been viewed as an ideal environment for behaviourist concepts Because software may provide such a learning environment, online. For instance, it is thought that the ability to design online tests that give students rapid feedback

regarding their understanding of the subject is extremely compatible with behaviourist principles.

Rewarding students for their performance is still important in online teaching and learning. A behaviourist approach involves rewarding leaners for their hard work with accolades or praise points (even verbal praise). The behaviourist theory is also manifested in online learning through the way we teach students to revise for examinations. It is unmistakably behaviourist to repeat assignments and tests in an effort to raise test scores and, eventually, one's grade. Students discover that the more practice they put in, the more compliments they will get for doing well and getting better scores.

Reinforcement is the hallmark of behaviourism. While online learning does not always involve face to face interactions with the lecturer, students can still take their dose of positive reinforcement through feedback that could take many forms. A behaviouristic-oriented instructional design method for online learning must have as its goal giving students the right stimuli and opportunities to show that they can exhibit desired behaviours that demonstrate learning.

2.2.2 Constructivism

Constructivism is a learning philosophy founded "on the idea that each person builds their own knowledge through interactions with the environment and other people who are also learning" (Vygotsky, 1979, p. 79). It is a philosophical and psychological strategy that operates under the premise that people, behaviours, and environments engage in reciprocal interactions (Dagar & Yadav, 2016). The constructivist perspective is divided into two main historical strands: cognitive constructivism, which was developed by Jean Piaget, and social constructivism, which was developed by Vygotsky.

2.2.2.1 Cognitivism

Early in the 20th century, cognitivism emerged as a learning theory in response to unhappiness with the behaviourist tradition's inability to explain mental processes (Steffens, 2015). Therefore, the theories of philosophers like Tolman, Piaget, Vygotsky, and Bruner sparked the radical transition from behaviourism to cognitivism (Steffens, 2015). Among cognitive

constructivists, Piaget (1973) and Bruner (1978) are regarded as the leading theorists. Piaget disagreed with the notion that learning consisted of rote memorisation of preexisting information. Instead, he claimed that:

> … learning is an active process that involves adjusting to reality in a series of steps, during which time students actively construct knowledge by developing and refining their own conceptions of how the world works (Piaget, 1973).

Cognitivism holds that learning is a mental process involving memory, thought, motivation, and metacognitivism. Cognitive theorists believe that learning has occurred "when cognitive frameworks termed schema have been processed and stored as knowledge in memory banks by people" (Powell & Kalina, 2009, p. 245). In order to prevent overload, the taught material is typically delivered to the student in a hierarchical order and in bits and pieces at a time. Cognitivism promotes rote learning in which students memorise material to acquire a skill, which could be problematic if the learning environment changes. It is possible that students will not be able to use the same idea that they have stored in their memory banks.

Cognitive constructivists claim that each learner builds his/her own knowledge and develops his/her ideas through personal experience (Powell & Kalina, 2009, p. 241). Since knowledge is absorbed, organised, stored, and retrieved by the mind, cognitivism focuses on conceptualising students' learning processes. The following assumptions about instructional design are made according to the cognitivist viewpoint:

> …learners are actively involved in the learning process, lessons are built upon prerequisite lessons, and information is structured, organised, and sequenced to facilitate optimal processing. Learning environments are created to allow and encourage students to make connections with previously learned material (Ertmer & Newby, 2013, p. 53).

The cognitive constructivist learning theory encourages reflective self-enlightenment and encourages learning through discussion. When learning, students build their own knowledge while actively participating in discussions with teachers to deepen their past knowledge.

2.2.2.2 Social constructivism

Lev Vygotsky is considered the chief theorist of social constructivism. Vygotsky's view of knowledge is that:

> …all knowledge is constructed socially and every function in the child's cultural development appears twice: first, on the social level and, later, on the individual level; first, between people which is inter-psychological and then inside the child which is intra-psychological (Vygotsky, 1979).

Social constructivism places a strong emphasis on the fact that education involves the social process of learning. Learning is viewed as a process in which students independently learn to find out facts, ideas, and principles. Social constructivism emphasises the idea that students should actively participate in their own learning process. Social constructivism emphasises that:

> …all cognitive functions including learning are dependent on interactions with others (e.g., teachers, peers, and parents), and that learning is critically dependent on the qualities of a collaborative process within an educational community, which is situation specific, and context bound (Schunk, 2012).

Social constructivism holds that learning is centred on using shared experiences and interactions with others to handle real-world, adaptive challenges in a social setting. As a result, the learner adapts rules to make sense of the outer world as new concepts are compared to existing knowledge. According to social constructivism, learning occurs as a product of group interactions rather than as something that happens to an individual and is centred on the learner as a member of a social group. Learning is not seen as a passive process of growth in response to external stimuli, but rather as an active social process. Pool and du Toit, (2014) therefore claim that:

> …social constructivism acknowledges the uniqueness and complexity of the individual learner and values, utilizes, and rewards it as an integral part of the learning process.

According to social constructivism, knowledge is a human creation that is actively built in society and culture rather than being something that can be found (Kim, 2001). When people connect with one another and their surroundings, meaning can be created. Hence, knowledge arises as the results of internal contradictions brought about by interactions with other

individuals in the environment rather than being connected to either the outside world or the functioning of the mind (Schunk, 2012). Figure 2.1 shows people involved in constructivist knowledge sharing in a teaching learning situation.

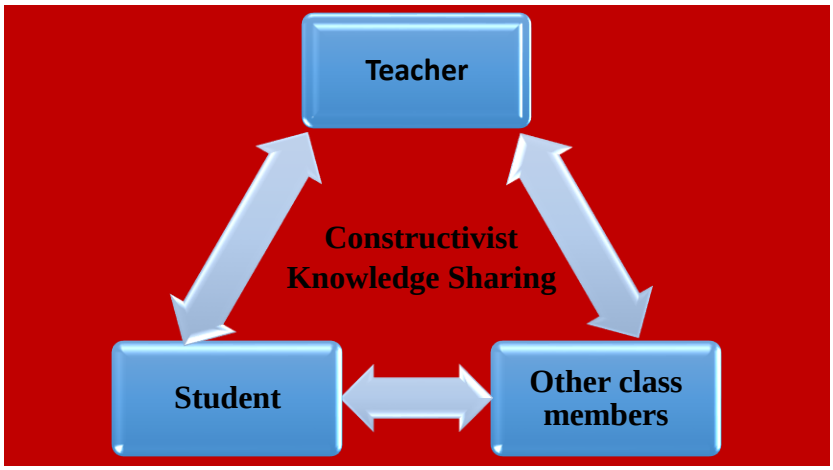


Figure 2.1: People involved in constructivist knowledge sharing in a teaching learning situation (Schunk, 2012)

2.2.3 Situated learning

Situated learning is a learning theory that holds that learning must be integrated in real-world contexts of practice where students complete tasks that are getting more and more difficult while participating in social networks. According to this theory:

> …learning should not be viewed as simply the transmission of abstract and decontextualized knowledge from one individual to another, but a social process whereby knowledge is co-constructed (Lave & Wenger, 1990).

Learning thus occurs in a specific setting and is integrated into a certain social and physical environment.

Hence, the foundation of situated learning is the notion that learning is contained in the environment in which the experience is taking place, rather than in the individual. Learners learn through socializing, imagery, and imitation. Individuals seek to solve problems as they begin to learn. When learning is problem-based, people research actual life situations to come up with solutions. Situated learning is thus advantageous in a teaching and learning environment. It improves students' cognitive level, their ability to generate new knowledge (and correspondingly new mental models), link or apply the knowledge obtained to deal with difficulties or situations in real life, and their level of active engagement in learning.

According to Hung (2002), technology is being used increasingly frequently in contextual learning to assist people absorb knowledge in ways that are different from how they have in the past. The method of learning a skill using technology is similar to how people previously learnt it from a specialist in that field. While learning about a particular subject in the past, people did it in person, with hands-on instruction. These identical tasks can now be completed using a computer or another similar device thanks to technology. One further technique to improve situational learning is through computer-mediated interactivity amongst people. This also gives students access to a different learning environment.

2.2.4 Social constructivism, the lens of this study

In this study, Moodle and self-directed learning are two online teaching components whose interactions are examined. Of the three learning theories discussed, the study used social constructivism as a lens to understand students' perspectives on Moodle in promoting self-directed learning. There are three main reasons why social constructivism was a choice lens of this study. The first reason is that this study was undertaken within an online context. According to research, **"**there is a mutual relationship between computer technology and social constructivism" (Psycharis *et al.*, 2013, p. 17). The second reason is that the focus of this study is on Moodle as an LMS. Research shows that Moodle pedagogy is based on a social constructivist pedagogical philosophy (Pool & du Toit, 2014). The third reason is that this study aims at investigating students' perspectives on self-directed learning. Most studies show that self-directed learning is based on social constructivism (Psycharis *et al.*, 2013; Pool & du Toit, 2014; Lara, Lizcano, Martínez, Pazos & Riera, 2014). These reasons are discussed in more detail in the next sub sections.

2.2.4.1 *Mutual relationship between computer technology and social constructivism*

Research reveals a mutual relationship between social constructivism and computer technology (Psycharis *et al*., 2013). According to Taber (2017, p. 398), "the use of technology in the classroom has been shown to change how students learn". By establishing a learning environment that is focused on the student rather than the teacher, changes take on a beneficial orientation. This is partly attributable to the conventional seatwork being replaced with computer-based learning tools. The classroom is transformed into an active space full of

meaningful activity where the student is made accountable for his or her learning, as opposed to a static teacher-centred environment where the students behave as receivers of information from a single source. The students are involved in worthwhile tasks like problem-based learning projects, researching online for information. The constructivist method is supported in computer technological teaching and learning environments where collaborating among students and debate of ideas are encouraged. Using computer technology makes ensuring communication simple. Students have the option to communicate verbally, visually, or in writing, either synchronously or asynchronously, thanks to computer technology. Students can discuss their ideas with others, share them, and amend any incorrect notions they may have.

Social constructivism was chosen as a lens because "it is the most common theoretical perspective on online learning, with a focus on collaborative discourse and the creation and sharing of texts and other social artifacts as a means of enhancing individual meaning" (Frankl & Bitter, 2012, p. 83). Advocates of constructivism make an effort to relate the use of educational technology in instruction with constructivist teaching and learning practices. Through group problem-solving strategies and processes, technology connects students to constructivist practice. The various synchronous and asynchronous communication tools available in technology-supported collaborative learning environments encourage discussion, a crucial component of socio-constructivist pedagogies that place a focus on the co-construction of knowledge among a community of learners.

The majority of researchers concur that social constructivism and computer technology are mutually inclusive, and that technology is a critical enabler of constructivist methodologies (Reynolds, 2016; Florian & Zimmerman, 2015). Constructivism is especially relevant to digital technology-based learning. Technology allows for the creation of intriguing things that can be learned from. The main objectives of constructivism are to emphasize creativity and to encourage learning via engagement. When learning is regarded as an activity rather than a passive involvement, it is seen to be more effective. The shift away from viewing education as being completely in the control of the teacher and toward one where teacher and student work together is where these ideas' significance may be seen.

Social constructivism was chosen as the lens for this study because it offers chances for scaffolding and rich learning environments in the context of online education. The term scaffolding describes:

> …a teaching strategy in which instructors provide students with a specific form of assistance while they acquire and master a brand-new idea or ability. A teacher gives information or show students how to address an issue while using the instructional scaffolding methodology (Frankl & Bitter, 2012).

In the theory of social constructivism, the idea of scaffolding is quite similar to the idea of social interaction. In terms of pedagogy, scaffolding happens when a lecturer assists a student to the point where the scaffolded person may eventually do the work at hand on his or her own (Amerian *et al*, 2014). Technical scaffolding is what academics refer to as "scaffolding in the context of online education" (Yelland & Masters, 2007, p. 367). Technical scaffolding refers to the availability of online resources that students can access when they need assistance understanding a certain topic, reading, concept, or task, such as webpages, online tutorials, or videos.

2.2.4.2 *Moodle is based on a social constructivist pedagogical philosophy.*

This study chose social constructivism as its lens due to numerous research demonstrating that Moodle is founded on a social constructivist pedagogical philosophy (Reynolds, 2016; Florian & Zimmerman, 2015). An inquiry-and-discovery-based method of online learning is made possible by a set of tools made available by Moodle. Williams (2005) outlined the four primary justifications for the social constructivism-based foundation of the Moodle learning philosophy. People build new information from the contexts in which they learn; learning is particularly effective for students; cooperation is the basis of learning; and students are connected and take part in discussions.

The study by Devi and Lakshmi (2020) as well as Finnegan and Ginty (2019) found that Moodle is grounded in social constructivism pedagogy and is designed to support a social constructivist framework of education. They all argue that:

> …Moodle pedagogy follows the principles of constructivism and encourages active learning (through e.g., its glossary and wiki), collaborative learning (through e.g., collaborative management of wikis, fora, glossaries, assignments, etc.), creative, integrated, and evaluative learning. Moodle therefore enables the participants to learn through interaction, based on the principles of social constructivism (Devi & Lakshmi, 2020; Ginty, 2019).

Each team member thus gains knowledge from the other participants, and each team reference has instructional value since it may be assimilated by the other members as a newly acquired body of knowledge. According to Lara *et al*. (2014), social constructivist pedagogical functions and Moodle learning environments are closely related in that students collaborate to build an integrated set of knowledge, attitudes, and skills on their own (in their minds) so they can solve problems in (real life) and produce observable artifacts that lessen people's discomfort.

Social constructivism and Moodle pedagogies promote the construction of knowledge (learning experiences) and self-directed learning which enhances self-directed learning (Pool & Du Toit, 2014). According to Reynolds (2016, p. 742), the majority of the Moodle teaching and learning models "are founded on social constructivism, wherein students are given responsibility for managing their own learning". Motivated, independent, and metacognitively engaged learners are those who can control their own learning (Pool & du Toit, 2014).

Moodle was created with constructivist education in mind, which holds that knowledge is produced in the student's mind rather than merely conveyed, and encourages collaborative learning (Psycharis *et al*., 2013). Moodle was created with constructivist education in mind, which holds that knowledge is produced in the student's mind rather than merely conveyed, and encourages collaborative learning (Psycharis *et al*., 2013).

Social constructivism was chosen as a lens because like Moodle, it promotes collaborative learning. The focus is on the sharing of individual meaning and on the knowledge constructed via cooperation with peers. Collaboration between students and between students and teachers helps to increase learning. According to the social constructivist theory, students are actually negotiating meaning and constructing knowledge as a community rather than as individuals when they share background information and engage in give-and-take collaborative activities.

2.2.4.3 *Self-directed learning pedagogy is based on constructivism*

This study was conducted within the context of higher education with focus on self-directed learning. Du Toit-Brits (2019, p. 6), argues that "Higher education encourages students to construct their learning pathway and use previous and current experiences, along with future aspirations, to influence the direction of this pathway". De Beer and Gravett, (2016) describe this as self-directed learning. In this study self-directed learning is therefore presented based on social constructivist starting points. This therefore mitigates social constructivism as a lens that guided this study. Learning is defined as a process that is introspective, socially engaged, contextual, constructive, and self-regulated.

Social constructivism was chosen as a lens because research studies show that there is a link between social constructivism and self-directed learning. For example, Douglas and Morris (2014, p. 16), argue that "self-directed learning is based on social constructivism because it is a social-interactive, contextual, constructive, self-regulated and reflective process". This shows that constructivism is related to self-directed learning. This is alluded to by Du Toit-Brits and van Zyl (2017, p. 7) who argues that "most theories of self-directed learning are presented based on social constructivist starting points".

Merriam *et al*., (2012) argue that:

> …social constructivism is related to self-directed learning and that self-awareness, self-monitoring, critical and creative thinking, and developing learning styles are the four fundamental skills of learners.

Self-directed learning is considered to be one of the key learner qualities in constructivism. According to prior scientific study, self-directed learners tend to be independent, able to apply information to real-world situations, and accountable for their learning environment (Vaivada, 2012). Conducting self-directed learning, according to Wu (2004), is one of the traits of a lifelong learner. It might therefore be argued that those who exhibit the traits of self-directed learners within the constructivist context can be lifelong learners. Those who are lifelong learners are well-informed and deeply understanding. They enjoy exploring new learning opportunities, using their planning skills, problem-solving abilities, and capacity to apply learning methodologies. It is evident that lifelong learning can result from self-directed learning within a social constructivist environment.

Du Toit-Brits (2019) argues that both SDL and social constructivism need the following demands for education to be successful:

> …a curiosity and a desire to know, creativity in cultivating innovative ideas/solutions, a willingness to think and reflect on problems, the ability to share own thinking with others, accepting criticism and building on that, the ability to solve problems creatively, which leads to knowledgeable opinions and decisions, the ability to think logically, being a mediator of constant change, continuous self-development and the ability to learn on one's own, an ability to participate in interactive teaching-learning experiences, being self-directed, the ability to place knowledge into real-life contexts and lastly, becoming 21st-century students/individuals learning from inquiry, design and collaboration (Du Toit-Brits, 2019).

Knowledge is thus not seen as being transferred from one person to another as a finished good in social constructivism and self-directed learning because of this. Social constructivism and self-directed learning therefore view knowledge acquisition as not being transmitted from one person to another as a finished product, but rather as being acquired through personally meaningful experiences and reflections. Hence, learning by doing and accomplishing practical, intrinsically rewarding tasks are valued in constructivism and self-directed learning. Students try to solve challenges and foster their creative thinking as a result, celebrating constructivism and self-directed learning.

Social constructivism and self-directed learning have been connected by researchers like Douglass and Morris (2014). The social constructivist methodology and design tenets assist the development of learner-driven, active, constructive, and meaningful learning resources that encourage self-directed learning. Constructivist concepts work well with SDL and promote student engagement. Du Toit-Brits (2015) argues that independent and self-directed learners develop autonomy and a realization of the existence of an infinite realm of knowledge. Rezaee and Mosalanejad (2015, p. 302) go on to say that "because of the learners' physical location, self-directed learning offers a special context for incorporating constructivist principles". The learner's involvement in his/her active learning should be one of self-motivation, self-direction, interaction, and cooperation.

In order to promote active, collaborative, and responsible learning, constructivist perspectives also reflect the autonomy demanded by SDL proponents. By virtue of their geographical position, students are expected to participate in their learning experiences as self-motivated, self-directed, interactive, and collaborative individuals, according to social constructivist concepts. Student engagement is fueled by motivation in both social constructivism and SDL.

Students who lack motivation will not organize their knowledge or put what they know or think about to use. According to Du Toit-Brits (2015, p. 43), lecturers should "inspire students and promote intrinsic motivation so that they can use constructivism and self-directed learning opportunities to improve their learning autonomy".

2.3 The Planned E-learning Interactions Framework: The theoretical framework that underpinned this study

2.3.1 Explanation of the theory

The Planned E-Learning Interactions Framework is one of the theories that fits the educational and didactic usage of Moodle and self-directed learning (Hirumi, 2013). This theory offers "classroom or face-to-face interaction as well as online support which help to foster rising levels of autonomy in both students and teachers—who are viewed as mediators, facilitators, and designers of learning situations" (Parson, 2017, p. 275).

Constructivism theory and The Planned E-learning Interactions Framework have a connection. Admiraal *et al* (2017, p. 62) claim that "they both support the creation of learning environments and designs based on the idea that students actively construct their own knowledge and meaning from their experiences". As a result, this study used the Planned E-Learning Interactions Framework as a theoretical framework because the context of the study is Moodle self-directed learning. The self-directed learning component within an online context is understood using the Planned E-Learning Interactions Framework. The learning model of this theory includes a learning process that involves interactions between humans (students) and non-humans as well as self-directed learning as a personal quality (computers). Hirumi (2013) analysed, created, and sequenced planned e-learning interactions using the The Planned E-learning Interactions Framework. This theory was chosen because these pre-planned online learning interactions serve as a solid basis for independent learning. Hirumi (2013) thought that as part of the e-learning process, interactions needed to be intentional, planned, and put in a sensible order. He devised a three-level model that he believes should be used to organise interactions as part of the eLearning process (see figure 2.2).

These levels are:

I. The lower level, where the lecturer instructs the students.

II. The middle level, where students engage with computers and their environment and,

III. The upper level is when the student takes in what they could have learned and applies it to the creation of others and the solution of connected difficulties.

Interactions at the Level I happen within each individual learner. The learner interacts with both human and non-human resources at Level II. An e-learning approach is defined by Level III interactions, which are a collection of Level II interactions that are organized and timed to encourage Level I interactions. Each level is described from the perspective of the learner. This is not to mean that the instructor's viewpoint and other points of view are unimportant. Instead, focus is given to the students and their needs here.

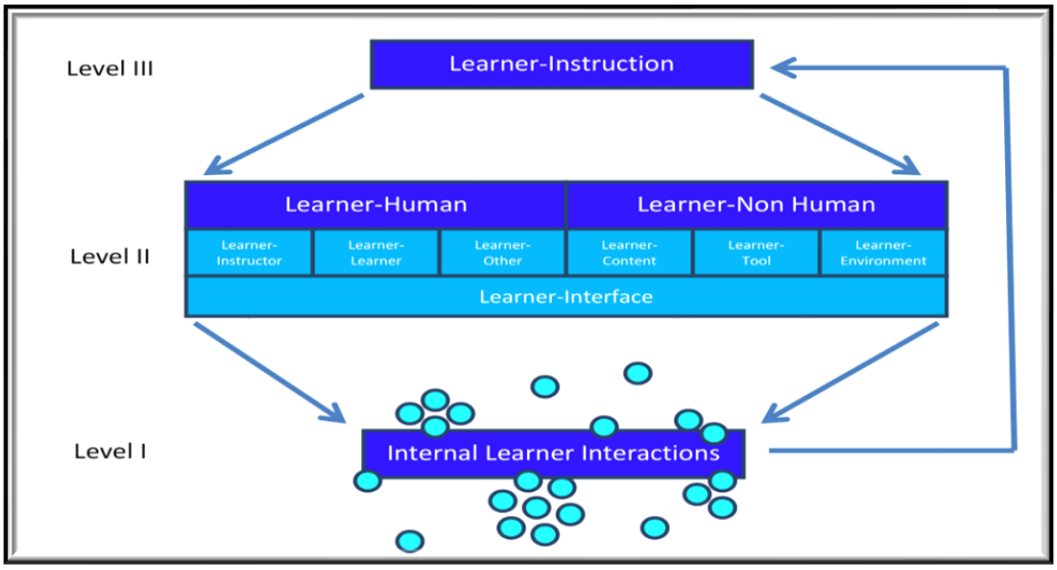


Figure 2.2: Three levels of Planned eLearning Interactions (Hirumi, 2013)

2.3.2 *Discussion of the levels*

2.3.2.1 Level I: Learner-Self Interactions

Hirumi (2013, p. 2) defined Level I interactions as "those that take place within a single learner in which both the cognitive processes that make up learning and the metacognitive procedures that aid people in monitoring and controlling their learning are included". The epistemological assumptions of the instructional designer influence the unique cognitive processes that take

place within an individual. At this level, students are motivated, self-directed, and capable of exercising self-control when learning. According to Voskamp, Kuiper and Volman (2020, p. 786), "students become self-regulated to the degree that they actively participate metacognitively, motivationally, and behaviourally in their learning".

2.3.2.2 Level II: Learner-Human and Learner Non-Human Interactions

The learner interacts with other human and non-human eLearning resources at Level II. The purpose of these interactions is to promote Level I interactions.

2.3.2.2.1 Learner Human Interactions

Learner-instructor, learner-learner, and learner-other human interactions are all examples of learner human interactions.

Learner-Instructor Interactions

Interactions between students and instructors that start before, during, or right after instruction are referred to as learner-instructor interactions. According to Moore (1989), interactions between students and teachers are attempts to energise and excite them as well as provide opportunities for them to ask questions when they are unclear about the course material. According to Thach and Murphy, (1995), distance teacher competencies reveal seven key learner-instructor interactions:

> …To establish learning outcomes/objectives; to provide timely and appropriate feedback; to facilitate information presentation; to monitor and evaluate student performance; to provide (facilitate) learning activities; to initiate, maintain and facilitate discussions; and to determine learning needs and preferences.

Feedback is a critical component in these interactions.

Learner-Learner Interactions

This kind of interaction takes place between students, either alone or in groups, and with or without the instructor's actual presence. The teacher might be there or not. As part of their education, students are frequently forced to collaborate on assignments and projects. Students must typically work together in these encounters to interpret and understand data, solve problems, and share knowledge, views, and ideas. These encounters assist both individuals and

groups in developing and putting to use specific skills and information. The mere assignment of people to groups does not guarantee that they will cooperate. Just placing people in groups does not guarantee that they will collaborate.

Learner-Other Human Interactions

These interactions take place between the learner and the technology. Learner-other human interactions utilize:

> …the potential for telecommunication technologies to break down the barrier of classroom walls and enable students to search for, access, acquire and apply a wealth of information from a variety of external resources (Bonk, 2010).

In order to encourage knowledge production and social discourse, an increasing number of online courses require students to read outside websites and speak with other students outside of class. As part of these interactions, students and academic support personnel may converse with teaching assistants, mentors, and subject matter experts.

2.3.2.2.2 Learner Non-Human Interactions

Learner Non-Human Interactions consist of Learner-Content Interactions, Learner-Tool Interactions and Learner-Environment Interactions

Learner-Content Interactions

The learner and the content engage in these interactions. The content may take the form of text, pictures, audio, or video.

Learner-Interface Interactions

The interactions at this level occur between the learner and the (computer) interface. The interface acts as a place where the student and the knowledge meet. If users are comfortable with and competent with using computers, they may be more likely to succeed at this level. When a computer is the main means of delivery, its user interface is the main point of contact. The interface must support students' ability to use electronic tools, acquire information,

decipher visual cues, and finish task-oriented tasks. A learner's success in gaining knowledge from a certain media is positively correlated with their level of proficiency with that medium. According to Hirumi (2013, p .5), “before students can be expected to successfully interact with human and non-human resources, they must first have the technical abilities required to operate the delivery system”.

Learner-Environment Interactions.

These interactions occur between the student and the community at large. Interactions do not specifically involve computers or the actual classroom. When students engage in eLearning outside of the computer interface, they are engaging in learner-environment interactions. Students have to:

> …clearly define the required learning outcomes and identify when such experiences are essential for the achievement of those outcomes; carefully plan and coordinate the interactions so that students readily understand what is expected of them and why it is important for them to interact with their environment; and integrate the event with other interactions and embed them within a sound instructional strategy to optimize the experience and ensure students reach the specified objectives and achieve the greatest return from time and effort invested on arranging such learner-environment interactions (Chou & Zou, 2020).

2.3.2.3 Level III: Learner-Instruction Interactions

At this level, learner-instruction interactions take the form of a sequence of activities (or an eLearning strategy) required to fulfill a predetermined set of goals. As a result, they encourage learning and make achieving goals easier. Interactions at Level III are seen as meta-levels that go beyond and structure interactions at Level II. These interactions purposefully encourage learning and serve as a motivator for achieving educational objectives. Learner-instruction interactions are distinguished from Level II and Level I to show how theoretically based teaching approaches may be used to support online teachers in developing and sequencing planned online interactions.

Hirumi's framework was selected as the study's guiding theory because it offers a framework for universities to follow in order to strategically prepare for, manage, and sequence interactions in online courses in order to promote self-directed learning. This idea can be

applied to independent and self-directed learning while also being apt to further enhance study autonomy. The eight stages (see figure 2.3) that characterize a student-centered, technology-based module that can aid students in building their knowledge for self-directed learning are presented by Hirumi (2002) in his schema. Hirumi (2002, p. 163) identifies these eight processes as "setting learning challenge, negotiating goals and objectives, negotiating learning strategy, constructing knowledge, negotiating performance criteria, assessing learning, providing feedback of steps 1 - 6, and communicating results".

Hirumi (2002) has diagrammatically illustrated these processes as follows:

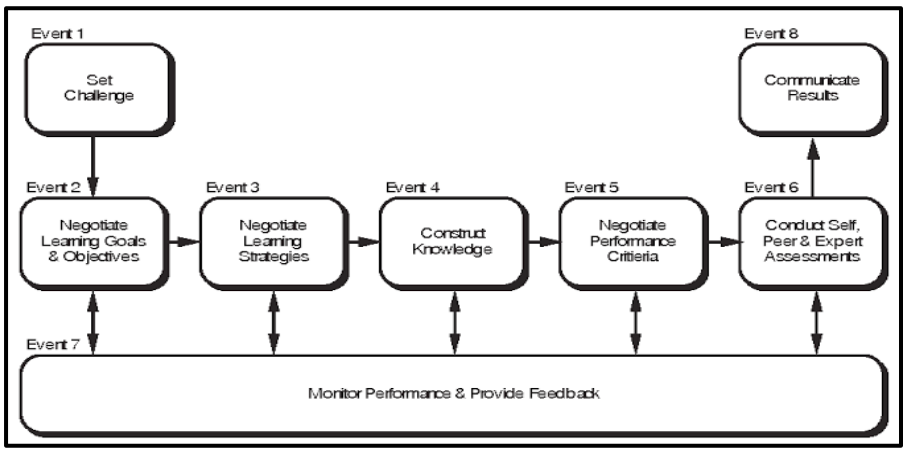


Figure 2.3: Processes set to assist learners to construct knowledge based on their previous knowledge (Hirumi, 2002, p. 163)

Thus, this study is informed by Hirumi's (2002) hybrid e-Learning framework. The three levels and their constituent parts of Hirumi's e-Learning framework were deemed appropriate for promoting SDL (Hirumi, 2013). These levels represent the steps a student takes to achieve self-directed learning.

2.4 Chapter conclusion

This chapter outlined the main theories that framed and guided this research. In this chapter, three main theories associated with learning were discussed. The fourth theory related to technology was also discussed. This chapter presented the relevant aspects of the theory of social constructivism and the Planned eLearning Interactions Framework that formed the basis for the lens of this study.

The theory of planned e-learning interactions was chosen as a lens of this study because it provides a solid framework for comprehending the ideas, procedures, and findings of this study. Its model of teaching is based on constructivist ideas of teaching. The Planned eLearning Interactions Framework theory represents a good foundation for understanding concepts, processes, and conclusions presented in this research project. The levels of this theory indicate a learner's journey towards the achievement of self-directed learning which is the main theme of this study.

The next chapter presents a review of the literature related to the key issues of this study.

CHAPTER 3: THE LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

3.1 Introduction

This chapter presents a discussion of the literature review and the conceptual framework that guided this research. Creswell and Creswell (2018) define literature review as:

> …the process of gathering, reading, and studying relevant background information on the phenomenon under study, and involves reviewing material such as books, documents, white papers, and journals, which are rich sources of information.

Literature study helps the researcher to compare opinions and findings. The focus of this study is Moodle and SDL. In reviewing literature, the researcher in this study conducted an extensive study of the previous research work done on Moodle and SDL.

3.2 Online learning challenges experienced by first year university students when using Moodle in South Africa and Sub-Sahara Africa

First year university difficulties in using Moodle is as a result of digital divide. Literature shows that there is an acute digital divide in South Africa (Du Preez & Le Grange, 2020; Moonasamy and Naidoo,2022; Pather, Booi & Pather, 2020). Digital divide is defined as "a social inequality between individuals regarding access to ICT, frequency of use of technology, and the ability to use ICT for different purposes" (Ercikan et al., 2018, p. 4). According to Pather, Booi and Pather (2020), digital divide refers to the gap between people who can access different types of information and communication technology (ICTs) and those who are unable to have access to it. Jantjies, (2020) avers that South Africa's digital divide is driven by broken down into three factors, access to hardware, understanding digital means of communication, and internet affordability. These are the factors that contribute to first year university' challenges with online teaching and learning. This is alluded to by Naidoo and Israel (2021) who argued that online learning becomes challenging due to not having digital devices, the lack of internet connectivity and the high cost of data. According to Aboagye, Yawson, and Appiah, (2020, p. 113), "accessibility is the most important challenge students are facing in an online learning situation". University students will find it difficult to migrate to online learning if they are unable to access the digital tools and end up falling behind or dropping out.

First year university students also have technological gaps and therefore lack of technical skills to use Moodle online platforms. These students are expected to navigate through Moodle online

learning platforms even though they lack required skills, and also confront difficulties in operating a computer and its peripherals (Faloye & Ajayi, 2021). According to Coman, Tiru, Schmitz, Stanciu, and Bularca (2020), the lack of technical skills to use online platforms negatively affects many university students. One of the major concerns regarding online learning is that students have to be trained on how to use their gadgets to access material on online platforms and to use office-word tools (Palvia, Aeron, Gupta, Mahapatra, Parida, Rosner & Sindhi, 2018). In many cases this has not been the case; many universities only put out some guidelines on how to access material, forgetting that not every learner knows how to even get started on their personal computer or smart phone. The challenge is that students are not awarded time for online training (Joubert & Snyman, 2017). The negative impact is that the time passes, and the student still has not completed the tasks; be it registration of courses or even academic registration. Students will therefore experience technical difficulty which is one of the challenges that millions of university students around the world are experiencing (Joubert & Snyman, 2017). These students who lack training on how to use technological tools, find it hard to access material as well as submit their work in the online platforms provided. To sum it all, Pather, Booi, and Pather (2020) maintain that one of the primary challenges that exist in South African universities' plight to transform the online programme delivery is that of the resource readiness of the average South African university student.

3.3 Literature review on Moodle studies

3.3.1 Literature Studies on Moodle usability as a Learning Management System

The usability of Moodle as an LMS has been the subject of extensive research, which is closely related to the subject of this study (Hasan, 2019; Mthethwa & Maphosa, 2020). Nielsen (1994) defines usability as the degree to which a product may be used by certain users to achieve specific goals with effectiveness, efficiency, and satisfaction in a specific user context. According to Nielsen (1994), when it comes to web usability, making web sites easy to traverse and logically organized aids users in finding the information they're looking for. Mthethwa and Maphosa (2020, p. 29) asserts that "usability improves learnability, which in the context of e-learning refers to users' capacity to efficiently acquire and retain knowledge and skills". Usability has been cited by Rabaa'i as one of Moodle's qualities (2016). Rabaa'i (2016) argues that:

> …Moodle has a variety of useful options for students such as easy installation, customization of the options, security and management, easiness of navigation, software attractiveness and users' satisfaction**.**

To forecast their level of adoption of Moodle, the majority of researchers employed the Technological Acceptance Model (TAM), an established theoretical approach. One of the most popular models of technology acceptance used by researchers is the Technology Acceptance Model. This model "focuses on the two main elements that affect a person's intention to utilize new technology, namely, Perceived Usefulness and Perceived Ease of Use" (Davis, 1989, p. 320). Perceived Usefulness is defined as:

> …being the degree to which a person believes that the use of a system will improve his/her performance, and extent to which a student believes that using the technology will enhance his or her performance (Davis, 1989)**.**

According to Jonas and Norman (2011), perceived usefulness can consequently be a significant predictor of technology usage intention. There is evidence from numerous studies that suggests perceived usefulness affects attitudes and intentions toward using technology (Ankiewicz, 2019; Teo, 2011). Both Ankiewicz (2019) and Teo (2011) discovered a strong link between attitude toward using behaviour and perceived usefulness. Weerasinghe and Hindagolla's (2017) study, which also discovered that perceived usefulness impacts on attitude and on intention and aids in the progress of implementation, also revealed that perceived usefulness has a substantial impact on attitude towards using Moodle, alludes to this.

Perceived Ease of Use (PEOU) is the degree to which a person thinks using a system will not be difficult. Davis (1989, p. 320) defines Perceived Ease of Use as defined as "the degree to which a person believes that engaging in online transactions will be devoid of effort". Furthermore, according to Jonas and Norman (2011), PEOU refers to how much a student thinks using technology will be simple. The attitude toward using the technology is considered to be a key component of perceived ease of use. PEU is consequently the primary factor influencing how widely ICT is adopted and used (Hsu, Wang & Chiu, 2009). This conclusion was supported by Jahangir and Begum (2008), who discovered that PEOU had a favourable impact on behavioural intentions to utilise various technology applications. Persico *et al*. (2014, p. 618) discovered that "perceived ease of use had a substantial impact on students' attitudes toward using Moodle in their study of understanding university students' behavioural intention to utilize e-learning".

The usability of Moodle as a learning management system has been the subject of numerous academic studies by various researchers. For instance, Rabaa'i (2018) examined the variables that affect college students' decision to utilize Moodle as an e-learning platform. The findings of the study indicated that the factors perceived ease of use, perceived usefulness, and attitude had a favourable influence on the intention to utilize the Moodle online learning platform. Senol *et al*. (2014) used surveys to assess Moodle's usefulness based on 413 students' impressions after Kocaeli University in Turkey implemented it. The results indicated that various aspects of the Moodle interface did not meet the students' needs. In their study, Thuseethan *et al*. (2014) employed questionnaires to assess Moodle's usability from the viewpoint of the students in seven different schools. The findings demonstrated that students had several usability issues using Moodle, such as trouble logging in and sending assignments.

In their 2012 study, Escobar-Rodriguez and Monge-Lozano used TAM to predict or explain university students' acceptance of the Moodle platform. This study discovered that "attitudes toward technology use and behavioural intentions to use technology are influenced by perceived usefulness and perceived ease of use" (Escobar-Rodriguez & Monge-Lozano, 2012, p. 1088). In addition, Al-Sarrayrih *et al* (2010)'s study employed questionnaires to assess Moodle, a learning management system utilized at the Berlin Institute of Technology. Just 46% of the students agreed that they could recover quickly from mistakes, which indicated that they were not satisfied with Moodle's dependability. Rosato *et al*. (2004) used questionnaires to assess the usefulness of three different learning management systems, including Moodle. Examples of numerous usability issues that the students found on the systems were provided in the results. They included examining information across all platforms, publishing a discussion message in Moodle and WebCT, and turning in an assignment in Moodle. In addition, Ivanovi *et al*. (2013) used questionnaires to look into how students and teachers in two institutions in Serbia and Slovenia felt about Moodle. The findings demonstrated that Moodle was extremely well-liked by both teachers and students.

3.3.2 Literature Studies on the use of Moodle in teaching and learning

A software package called Moodle was created as a Learning Management System (LMS) and Course Management System (CMS) to allow instructors to design online courses that promote discussion and cooperative creation of learning content (Richards, 2015). Moodle was created

to assist teachers in producing high-quality online content and a collaborative, interactive setting to support their in-person lessons (Johnny, 2016).

Silva-Ordos *et al*. (2016) contend that this makes it possible for teachers and students to successfully include collaborative activities into the dynamics of the teaching-learning process when using Moodle for teaching and learning. Students build competencies that:

> …stimulate the formulation of questions, explaining and justifying viewpoints, articulating reasoning, developing, and reflecting on learned knowledge on the basis of didactic activities available in questionnaires, surveys, forums, and wikis, where the role of teachers is crucial in constructing didactic activities as well as in evaluating specific learning processes (Hashim & Jones, 2017).

From a practical standpoint, the Moodle platform includes easily adjustable features that enable the design of student evaluation processes (questionnaires and online tests) and the management of their assignments (Hasan, 2019). By offering an automated and adaptable educational assessment, it can also improve learning (Mthethwa-Kunene & Maphosa, 2020). These platforms enable the creation of fresh participatory tactics centred on students' learning as well as the development of metacognitive tactics that increase their autonomy (Silva-Ordos *et al*., 2016). In this regard, Makonye (2016, p. 201) argues that:

> …one of the best ways to promote SDL in mathematics is the use of authentic project tasks. The use of projects in mathematics pedagogy increases students' internal locus of control. In mathematics SDL as in other disciplines, students assume a high level of autonomy in controlling their own learning. In effect, SDL students have a high degree of self-efficacy and an internal locus of control. That means that they believe that the success of their learning is a result of their own efforts (p. 201).

Moreover, Moodle was developed with good pedagogical concepts to support teachers in developing successful online constructivist learning communities (Johnny, 2016). This is so that a course can be delivered entirely online or as a supplement to in-person lectures. Users of Moodle may build robust, adaptable, and active online learning environments that are simple to use and manage. Moodle gives instructors total control over the assignments and learning resources they give their students. The Moodle platform has three levels of use, namely the administrator, the teacher and the student. Their functions are represented in the following Table 3.1.

Table 3.1: Roles and functions in Moodle Platform

Role	Function
Administrator	**Controls the environment as a whole**
Teacher	**Create activities, lessons, or topics based on the specified thematic categories.**
Student	**accesses a particular event, participates in it, and engages with the topics to which he/she have subscribe**

The Moodle platform also has various resources which can be used for teaching and learning. Moodle (2012) identify three general categories of resources in Moodle.

- Learning resources: These are basic educational resources that the students read but do not engage with. Lectures may publish readings or notes from the class, link to relevant Web pages, or offer files for students to download.
- Assessment activities: Student interaction occurs with these course resources.
- Social learning activities: These are exercises where students converse with one another on the material being studied. This can take the shape of discussion forums, wikis, collaborative glossaries, and live online dialogues between students and teachers. So, Moodle supports the pedagogical theory that learning happens most effectively in a social constructionist setting.

Moodle provides several pedagogically sound tools and activities that can be utilized to improve teaching and learning (Mthethwa-Kunene & Maphosa, 2020).

3.3.3 What literature says about the advantages and disadvantages of Moodle Learning

3.3.3.1 Advantages of using Moodle

The studies by Johnny (2016) as well as by Hashim and Jones (2017) amongst others show that Moodle pedagogy has positive effect on the teaching and learning of students. These researchers mentioned the following as some of the advantages on Moodle pedagogy:

Innovation: Due to its foundation in the collaborative learning ethos, Moodle learning innovations frequently inspire teachers. Students gain knowledge through research, analysis, collaboration, sharing, and reflection.

Usability and stability: Both desktop and mobile users will have no trouble navigating the Moodle interface. In this case, simple and powerful is the appropriate description. It provides quick access, automatic and customized services, and hassle-free material presentation.

Security: Security fixes for Moodle are frequently updated to assist users in making sure their website is secure (Arkorful & Abaidoo, 2014).
High availability and scalability: Moodle provides a useful web-based interface that enables students, teachers, and administrators to regularly log in and complete their daily chores. By modifying the technology on which it runs, the Moodle architecture makes it simple to adjust to future demands; in other words, the infrastructure can scale to meet future needs (Johnny, 2016).

Personalisation of teachings methods: Moodle is a useful tool for teachers to customize their pedagogical approaches. Teachers can create or amend their lesson plans and upload them on Moodle. Also, Moodle gives teachers the ability to organize the students into groups and foster constructive rivalry and teamwork. One-on-one coaching can be provided via blogs, chats, forums, wiki modules, or emails.

Personalisation of extra curriculum activities: Extracurricular activities are essential for stimulating students' interest in their studies. Moodle modules offer the perfect setting for executing customized extracurricular activities.

Personalisation and diversification of evaluation system: A customized and varied assessment of the students' learning is provided in the Moodle-based education. In order to track and analyze students' online behaviours and examine the link between learner behaviour and learning outcomes, teachers can make full use of Moodle's learning features, such as records tracking and peer evaluation.

Flexibility: When it comes to considerations of place and time, Moodle is adaptable. The implementation of Moodle, according to Ghosh, Nafalski, Nedic and Wibawa (2019, p. 17), “gives institutions and their students or learners a great deal of flexibility about the timing and location of information delivery or receipt in accordance with learning needs”.

Relations between learners: Discussion boards in Moodle can help foster relationships amongst students. By doing this, Moodle assists in removing obstacles that may limit engagement, such as the anxiety about approaching other students. Moodle encourages student interaction, as well as the sharing and respect of opposing viewpoints.

Communication: Improved communication between students and between students and faculty or instructors is made possible by Moodle. Moodle encourages students to engage with one another, exchange ideas, and respect opposing viewpoints (Hashim & Jones, 2017). Moodle facilitates communication and enhances the bonds that support learning**.**

Assessment: From a functional standpoint, the Moodle platform "is easily flexible, enabling the establishment of student assessment procedures (questionnaires and online examinations), the management of their activities, and the ability to enhance learning by offering an automated and adaptive educational assessment" (Hasan, 2019, p. 2).

Medium full of diverse tools: The students can use Moodle, an LMS, which is a platform with a wide range of resources (Ndlovu & Mostert, 2017). Moodle has a structure that supports and encourages the level of interaction between participants in virtual training, which is influenced by the activities and actions teachers take (Luo, Murray & Crompton, 2017). Teachers can conduct interactive activities for online group discussions, tests, and evaluations using the Moodle functional modules. To improve the quality and effectiveness of their instruction, teachers can use Moodle to get feedback from students on their learning experiences as well as information on those processes.

According to Zacharis, Moodle has the following advantageous reasons:

> Easy to use (no programming knowledge is needed), access to resources via the web, interaction between learners and tutors, collaboration between learners, independent learning pathways, learner tracking, feedback on tasks, secure environment, automatic backup, and detailed gradebook based on work submitted by students listed (Zacharis, 2015).

3.3.3.2 Disadvantages of using Moodle

Studies have also been done on the disadvantages of using Moodle. The studies by Parson (2017) and Silva-Ordaz *et al* (2016) amongst others show that Moodle pedagogy has some

drawbacks. These researchers mentioned the following as some of the disadvantages on Moodle pedagogy:

Teachers' knowledge: Teachers' familiarity with the tools is essential for using Moodle, and they must therefore understand how to use these tools (Silva-Ordaz *et al*, 2016).

Absence of vital personal interactions: Moodle lacks the crucial interpersonal communication between students and lecturers as well as between them and other students (Admiraal *et al*., 2017).

Clarifications: Moodle might be less effective than the conventional learning technique in terms of clarifications, explanations, and interpretations. Face-to-face interactions with the instructors or tutors make the learning process considerably simpler.

Assessments: It will be difficult, if not impossible, to control or regulate negative behaviours like cheating as examinations for assessments in e-learning may be completed through a proxy. Plagiarism and the simplicity of copying and pasting could be widespread.

Socialisation: Moodle may also harm the socialization functions of institutions and the function of teachers in leading the educational process.

3.3.4 *Literature studies on the use of Moodle in South Africa and Sub-Saharan Africa*

Universities in Africa have seen extraordinary disruption as a result of the Corona Virus Disease of 2019 (COVID-19) pandemic, since several of them were forced to close as a precaution against the virus' risk. (UNESCO & IESALC, 2020). In order to continue teaching and learning while keeping their staff and students safe, many governments instructed universities to switch to technology-enhanced delivery methods. Several universities in Africa have therefore shifted some of their courses online, including those in Egypt, Ghana, South Africa, and Rwanda, among other nations (Ray & Srivastava, 2020). The COVID-19 lockdown measures in South Africa and Sub-Saharan Africa have therefore presented opportunities to see the technology's potential for continuity of education through various online platforms. During the pandemic lockdowns, a lot of technologies were deployed through various LMSs and other digital platforms to carry on teaching and learning activities over a remote distanced location. Higher institutions reviewed curriculum delivery and resulted in full use of various

LMS for teaching and learning activities to salvage the 2020 academic year. One of the mostly use LMS is Moodle.

Research done on the use of Moodle indicates that success, challenges, and hurdles were encountered during the implementation and use of Moodle as teaching and learning management system. For example, the study by Mahabeer and Pintheepal (2019) found that most of the lecturers found Moodle, as an online assessment tool, rewarding and flexible in providing quick constructive and operational feedback to students. Lecturers who were technologically shy and naïve favoured using Moodle as a blended measuring, monitoring, and reporting tool". This is corroborated by the findings of the study done by Sevnarayan (2023). Using observations, open-ended evaluation questions, and a focus group discussion, the study found that students appreciated the communication and interaction facilitated by the lecturers when using Moodle. The study by Mtebe and Raphael (2018) also report that the adoption of Moodle in African universities is increasing to enhance curriculum delivery.

Several factors have been identified as challenges to the adoption or effective use of Moodle and other LMSs in many HEIs in Africa, especially during the COVID-19 pandemic lockdown (Mpungose, 2020; Maphosa, Jita & Dube, 2020; Kumar, Charan & Venkatamuni, 2020). These studies reveal that students in HEIs in different parts of Africa experience diverse challenges in accessing or using LMS as the only adopted alternative to face-to-face classes or blended learning approaches before the lockdown. The biggest challenge is that of limited infrastructure, in particular limited access to power and the lack of affordable and reliable Internet access. In most African countries, Internet access is limited and slow. According to UNESCO, 89% of students in sub-Saharan Africa do not have access to household computers, and 82% lack Internet access (UNESCO, 2020). Where broadband is available, it is typically very expensive - far beyond the financial means of the majority of Africans and institutions. Equipping universities and keeping them up to date with ICT equipment is very expensive due to hardware and software purchases, as well as the recurrent costs associated with maintenance. Another challenged identified by research is that many African countries, and universities, face a shortage of ICT professionals and lack of educators with ICT skills. The integration of ICT in learning requires retraining. Lack of high-speed Internet infrastructures, low internet bandwidths, limited telephone connections, inadequate computer knowledge, low computer access, lack of adequate training for academics and students to engage LMS effectively for

teaching and learning were also identified as hindrances for effective use of Moodle. lack of computer skills.

These problems hinder online instruction and learning and Moodle implementation. For Moodle to be better implemented, it is extremely important to provide technological infrastructure, technical and administrative support. It is crucial that policy makers, administrators, etc. demonstrate a 'political' will by setting a policy and strategy in place at the institutional level, so as to create a viable and supportive environment for online instruction and learning. Otherwise, if such a will and support is not in place, instructors will be reluctant and unprepared to face the challenge of online education.

3.4 Literature on Self-Directed Learning

3.4.1 Literature on the conceptualisation of SDL

Houle (1961) introduced the idea of self-directed learning for the first time. In the 1960s, research on the idea of self-directed learning for adult education and as a response to the why and how of adult learning was conducted. The idea of self-directed learning has evolved recently, and arguments for its theoretical validity have begun to be made for both adults and children (Du Toit-Brits, 2020). Self-directed learning has also elevated in importance in light of the digital revolution and in keeping with 21st-century instructional strategies (Beach, 2017).

According to Shin (2011, p. 607), in the phrase self-directed learning, "the self is the subject of reflection or reflexive action, directed means to put clearly, and learn refers to developing knowledge or skills via practical application. Several terminologies have been conceived for describing SDL. These terminologies include:

> …autonomous learning, independent learning, lifelong learning, self-direction in learning, self-initiated learning, self-planned learning, self-instructed learning, self-regulated learning, self-managed learning, self-education, and self-teaching and have become related to SDL (Hill, *et al*., 2020; Singh & Paudel, 2020).

The employment of so many terminologies has made it difficult to adequately describe SDL. As a result, the literature on self-directed learning has a variety of viewpoints. Self-directed learning is viewed as a process by some researchers (Ranvar, 2015; Cadorin *et al*., 2017), a

learner attribute by others (Alharbi, 2018; Zainuddin & Perera, 2018; Williamson & Seewoodhary, 2017), and a design feature of the learning environment by yet others (Alharbi, 2018; Song & Hill, 2007). Hence, any SDL contains three basic parts: a process, a person, and a context (Brockett & Hiemstra, 2010). The process refers to the series of activities that a student goes through when taking ownership of their own education. The term person refers to individual traits and prowess that support independent learning. The setting of the learning experience is discussed in the context (Brockett & Hiemstra, 2010).

3.4.2 Literature on SDL as a process

The SDL is a method where students take charge of the instructional processes, such as planning, carrying out, and assessing learning (Merriam & Bierema, 2014). Self-directed learning is addressed as a process, as a method of learning in which people set their own priorities and select them from a wide range of readily available resources (Ranvar, 2015). It incorporates autodidaxy and learner control to some extent as a process. The most cited definition of SDL as a process is by Knowles in 1975. Knowles (1975) defines SDL as:

> …a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies and evaluating learning outcomes. This definition of SDL as a process therefore consists of five steps: (a) diagnosing learning goals; (b) formulating learning goals; (c) identifying human and material resources for learning; (d) choosing and implementing appropriate learning strategies; and (e) evaluating learning outcomes (Knowles, 1975).

This process is illustrated in Figure 3.1.

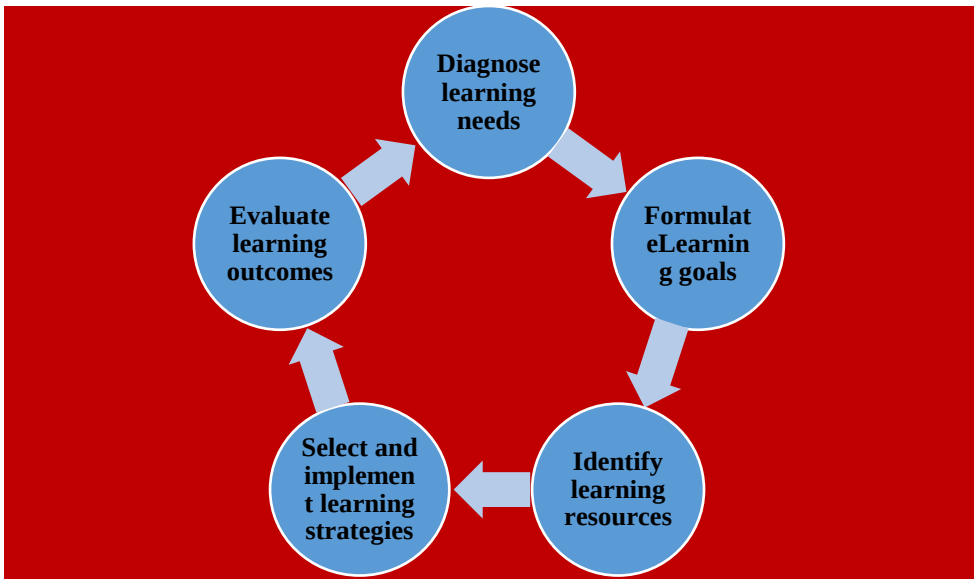


Figure 3.1: SDL learning process

Knowles (1975) used this notion in a classroom context where students were trained to define learning goals jointly, decide how to use resources for learning, map out how they would study to accomplish those goals, follow out the plan, and then evaluate how much learning had taken place. Knowles also assigned his leaners to be partners in choosing what should be covered in the examination. In each of these situations, he played the role of a facilitator to ensure that learning had taken place rather than just the passive transfer of knowledge.

Overall, studies on SDL show that "learners participate in real-world tasks, seek for and assess information to complete the learning, create learning goals and stay motivated to achieve them, self-monitor their performance while doing tasks, and create meaning from personal experiences" (Cadorin *et al*., 2017, p. 33).

3.4.3 Literature on SDL in an online learning environment context

Last but not least, SDL is seen as a design element of a learning environment that encourages learners to exert control over their learning (Alharbi, 2018). Each SDL process takes place within a learning environment or context. Merriam *et al*., (2012) postulated that:

> …learning environments that foster SDL are believed to promote deep-level processing in which learners seek meaning in the subject matter rather than surface-level processing where learners are engaged in rehearsal and memorization.

The context of a learning situation can be studied from several angles, including the context around a specific learner, the setting in which learning occurs, and the context of performance.

This study was conducted in an online learning environment. According to Henry (2020, p. 94), "the amount of given or expected learner control and learners' self-perception of their levels of self-direction are two factors that have an impact on SDL in the context of online learning". Song and Hill (2007) created a conceptual framework that included SDL as both a personal trait and a learning process, and they added the third context dimension to help explain how contextual influences, in this case those found in the online world, affect learner self-direction.

Communication and time management are the primary issues in the online environment. Compared to spoken communication in face-to-face learning situations, most communication in an online context takes the textual form, which can provide more possibility for misunderstanding. In the online environment, the timing of engagement and reaction from the teacher and the student also becomes an important consideration.

Steps in the SDL process such as "planning, keeping track of, and evaluating one's own learning will be impacted by the online environment" (Uz & Uzun, 2018, p. 882). In an online setting, learners have more autonomy, which gives them more freedom to design their own learning environments and workflows. It is the learners' obligation to keep track of their own learning and to know when to ask for help when they do not understand. In the online setting, students evaluate their own learning in a different way and occasionally receive comments from peers in addition to the facilitator. This was seen as a scaffolding process by Doo, Bonk, and Heeok (2020), with other students serving as a support network in the online learning environment.

3.4.4 Literature about SDL as a 21st century learning skill.

Several studies conceptualise SDL as one of the critical skills for 21st century (Tan, Divaharan, Tan & Cheah, 2011; Fonseca *et al*., 2014; Rashid & Asghar, 2016; Jaleel & Anuroofa, 2017). Self-directed learning as a 21st century skill that encompasses the following salient features:

> Ownership of learning, personal responsibility in identifying learning gaps and setting learning goals, self-management and self-monitoring, the process of managing tasks, time, and resources as well as the ongoing efforts of making improvements or taking actions to meet the learning goals; and extension of learning: Making links across disciplines, connections between formal and informal learning as well as interests in and out of school (Tan, Divaharan, Tan and Cheah, 2011).

These salient features are called behavioural indicators of SDL. Teachers can use these behavioural indicators to monitor and evaluate whether their students are engaged in SDL.

3.4.5 Literature on SDL and technology: understanding SDL in the online context.

According to Geng, Law and Niu, (2019, p. 5), "the concept of SDL has been recognised and researched for decades; however, digital revolution has brought it to the forefront and its context has changed with the presence of technology in current learning avenues". Technology has a direct impact on SDL because it has greatly facilitated access both to information resources and to online expertise. While Knowles (1975) first described the SDL process, it may be argued that learning to utilize contemporary technology requires a process similar to what he outlines. Boyer *et al*. (2013) assert that in order to keep up with the most recent technologies, individuals must be self-directed and adaptable.

Understanding what self-directed learning comprises is crucial to comprehend students' self-directed usage of technology for learning. SDL with technology is the use of ICTs for learning experiences that empower people to take charge of organizing, carrying out, and assessing their own learning (Geng, Law & Niu, 2019). The following are some instances of how ICTs can affect the SDL process:

> …collaboration with people, convenient and persistent access to worldwide information resources and opportunities, online communities involving several people from various disciplines for collaborative working and learning, and creative abilities cultivated through digital technologies (Lai, Shum & Tian, 2016).

Online communities underwent a second shift due to the interactive character of the online setting, which further mandates that SDL cannot occur in a vacuum. Students can engage in and share similar interests in online communities, grow their learning networks, and provide and receive peer feedback. These online communities also feature a social and interpersonal component. One example of such a community is service learning, in which students use what they have learned to work toward positive social change on a worldwide scale.

With technology acting as a branch that enables students to collaborate with others, the third transformation is about technological convergence, which enables students to access materials and resources through various communication channels. The strategy has evolved from focusing solely on what students need to learn to more recently adjusting channels and resources to their preferences in order to better promote learners' autonomy. The student has greater access and flexibility thanks to technology. Global connectedness is the fourth transformation. One transformation that impacts the SDL process is global connection (Mareco, 2017). In this regard, Tsai (2016) stated that:

> …global connectivity directly relates to SDL because it provides positive implications for economic competitiveness, personal fulfillment, and social inclusivity. Thus, this transformation of global connectivity links back to the emancipatory learning goal of SDL. The final transformation, digital creativity, gives learners the freedom to customise and design their own learning based on their interests while still being held to the key processes of planning, implementing, and evaluating their own learning.

The ICT use and self-directed learning are linked in a variety of ways, particularly in the educational setting. Technology enables students to create their own knowledge and feel independent while they are studying. Several studies demonstrate that technology directly affects self-directed learning since it has made it easier to access online information resources and expertise (Asfar & Zainuddin, 2015; Mareco, 2017). For the students, having unlimited access to a variety of information to meet their interests and learning goals is crucial for self-directed learning. They consist of gathering, storing, modifying, displaying, and connecting with other students and specialists around the world at the touch of a button without the need for elaborate formalities (Kim *et al*., 2014).

3.4.6 Research on the Models for self-directed learning

Several models were established by researchers to aid in the development of a better understanding of the application and facilitation of SDL in educational settings. This section discusses some of the most influential models of SDL.

3.4.6.1 Long (1989)

Long (1989) proposed an instructional model for SDL (see figure 3.2).

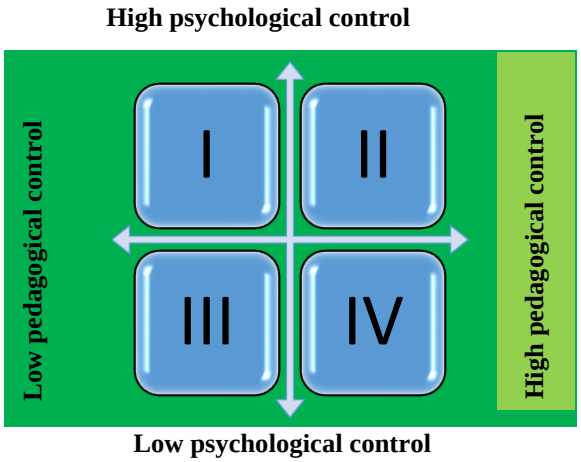


Figure 3.2: Long's model for SDL (Long, 1989, p. 3)

The two dimensions of pedagogical control and psychological control are the main focus of Long's model.

Long (1989, p. 3) defines pedagogical control "as the extent to which students are allowed to choose their own learning outcomes, use their own resources, and decide how they will be evaluated". In contrast, psychological control refers to how much a student is willing to maintain direct influence over their education. He contends that a circumstance can be described as a self-directed learning condition when pedagogical control and psychological control are on par or when psychological control is stronger**.**

There are four quadrants in Long's model. A setting with limited pedagogical control and great psychological control is described by Quadrant I. In this situation, a student who exhibits self-direction is paired with a facilitator who offers less support. A setting with great psychological control and high pedagogical control is depicted in Quadrant II. In this case, the student's self-direction is at odds with the facilitator's management of the learning environment. Exactly the opposite of Quadrant II is depicted in Quadrant III. While a student with inadequate self-direction won't be able to function if the facilitator is given charge of the learning scenario, a

setting where there is little pedagogical control and little psychological control is also an incompatible learning style. The fourth and final quadrant, known as quadrant IV, is characterised by strong pedagogical control, weak psychological control, and minimal self-direction on the part of the learner. Hence, whereas Quadrants II and III depict conflicting areas, Quadrants I and IV offer the optimum matches for a learning setting.

Control is the crucial element for SDL, according to Long (1989). He believes that:

> …for SDL to occur, pedagogical control and psychological control should be in balance (Quadrant I). Long (1989, p. 8) further contends that students that demonstrate a self-directed learning style will proceed to direct their own learning without pedagogical assistance. However, if it is not the student's orientation to direct his or her own learning, SDL must be supported by the facilitator (Long, 1989).

3.4.6.2 Candy (1991)

In 1991, Candy suggested a model of self-directed learning with two interrelated elements. (see figure 3.3).

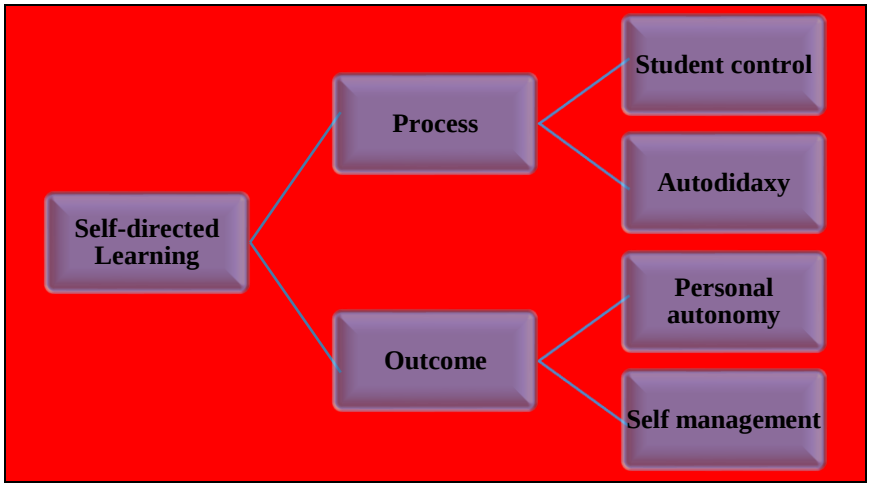


Figure 3.3: Candy's model for SDL (Candy, 1991, p. 22).

According to Candy (1991, p. 22), self-directed learning refers to "four different but connected phenomena: personal autonomy, self-management, student control, and autodidaxy". It encompasses both process and product (result) dimensions. According to Candy,

> ...personal autonomy represents one of the principal goals of education in all settings and all ages and refers to a personal characteristic or attribute of students and implies independence, freedom of choice, and rational reflection. Self-management refers to the willingness and capacity to conduct one's own education. Student control deals with control over aspects of the instructional situation, while

> the latter implies autodidaxy and concerns learning outside formal educational settings (Candy, 1991, p. 22).

Candy's model implies that a student's self-direction might be different in different content areas (Song & Hill, 2007, p. 29). Candy (1991, p. 22) claims that students "may exhibit high levels of self-direction in subjects or situations that are comparable to ones they have already experienced". He discusses how students can become more self-directed with an emphasis on developing the qualities of moral, emotional, and intellectual autonomy, and how self-directed learning can be seen as a process or an outcome. Orientation, support, and supervision may all be required in the early phases of a learning project; therefore, teachers should not assume that a student would be able to achieve in a new circumstance just because they were self-directed in a prior one, according to Candy (1991). This is due to the likelihood that a student's autonomy may change depending on the circumstance.

3.4.6.3 Brockett and Hiemstra (1991)

Brockett and Hiemstra (1991) created a model of Personal Responsibility Orientation (PRO) in self-directed learning (see figure 3.4).

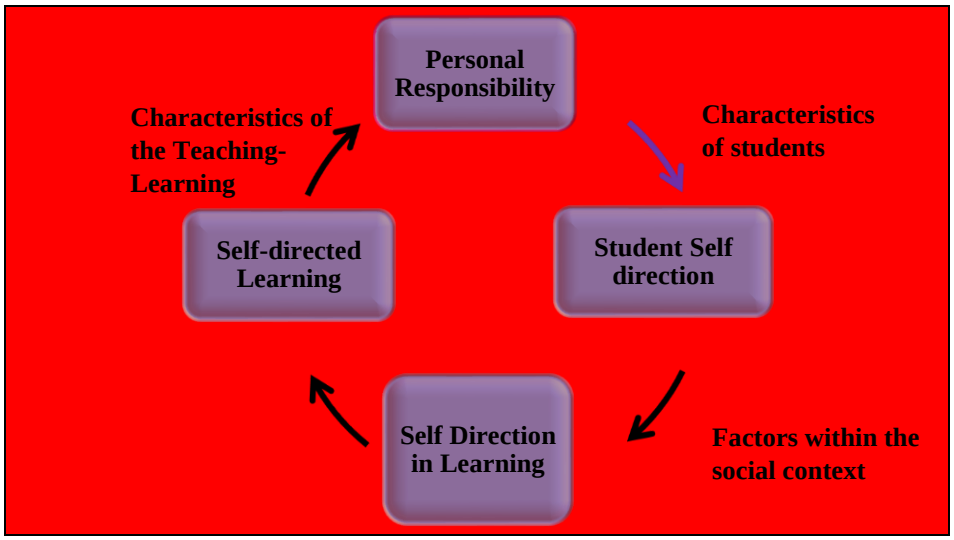


Figure 3.4: Brockett and Hiemstra's PRO model for SDL (Brockett & Hiemstra, 1991, p. 33)

The Brockett and Hiemstra (1991) SDL model shows two dimensions: (a) personal responsibility in the teaching and learning process, and (b) individual responsibility in one's own thoughts and deeds. He describes the models as follows:

> …In the first dimension, SDL is viewed as a process in which a student assumes primary responsibility for planning, implementing, and evaluating the learning process. In the second dimension, SDL is referred to as a goal, which focuses on a

> student's desire or preference for assuming responsibility for learning. People have control over their response to a situation even if they do not have control over the actual circumstances in which they need to react (Brockett & Hiemstra, 1991, p. 24).

Students that are self-directed are both willing and eager to take charge of their own education. Although students can choose the paths they choose in their academic careers, it is still their obligation to accept the results of their decisions. Brockett and Hiemstra (1991, p. 33) claim that "personal accountability is the cornerstone of acquiring self-direction". Yet this isn't enough; the teacher also needs to give SDL opportunity and assistance. This is due to the fact that Brockett and Hiemstra (1991) believe that when a student's amount of self-direction and the extent to which SDL possibilities are accessible in a particular context are balanced, optimal learning occurs. They stress the fact that learning is a social process and that social aspects of learning are crucial. They define the social environment as the numerous physical institutions where learning takes place, such as community colleges, libraries, and museums.

3.4.7 Research on the Measuring of SDL readiness

Geng, Law and Niu (2019) define self-directed learning readiness is defined as:

> …the degree to which the individual possesses the attitudes, abilities or talents and personality characteristics or features necessary for self-directed learning. Inherent in this definition are several assumptions about SDL readiness.

Fisher *et al*. (2010) contend that this definition implicitly presupposes that students fall somewhere along a continuum of preparation for SDL. Fisher *et al*. (2010) contend that the greatest method to acquire autonomous behaviour is to act independently, and that the abilities necessary for self-direction can be somewhat developed. Last but not least, the capacity for independent learning in one circumstance or context can be transferred to other contexts.
Different researchers used different scales to measure SDL readiness. The subsection below discusses different scales that were used in literature to measure SDL readiness.

3.3.7.1 Self-Directed Learning Readiness Scale (SDLRS)

According to Premkumar *et al,* (2013, p. 1768), "the instrument most frequently used in educational research to measure SDL readiness is the Self-directed Learning Readiness Scale (SDLRS)".

Guglielmino created this scale in 1977 to understand the effects of the unique traits, aptitudes, and motivations of self-directed learners. Moreover, it was created to evaluate a person's capacity and cognitive preparation for SDL. The SDLRS is a 58-item, 5-point Likert scale and measures eight factors, namely:

> …openness to learning opportunities, self-concept as an effective learner, initiative and independence in learning, informed acceptance of responsibility for one's own learning, love of learning, creativity, positive orientation to the future, and ability to use basic study skills and problem-solving skills (Premkumar *et al,* 2013).

The SDLRS is built around these factors. More readiness for self-directed learning is indicated by a high score on the SDLRS. Individual differences in readiness for SDL account for the range of levels along the continuum.

3.3.7.2 The Self-Rating Scale of Self- Directed Learning (SRSSDL)

Williamson (2007) created the Self-Rating Scale of Self-Directed Learning for use in higher education to identify the abilities needed for lifelong learners. It was designed to evaluate SDL behaviour, where the user's level of self-directed learning is rated as being either low, medium, or high on an ordinal scale. This scale gives users a chance to evaluate their behaviour and learning progress while also helping them stay motivated (Henry, 2015). The instrument, as shown by Williamson (2007), consists of sixty learning behaviour assertions organised into five primary sections:

> …Awareness: 12 items relating to learners' awareness of the factors concerning becoming self-directed learners. Learning strategies: 12 items identifying the various strategies learners should adopt to develop SDL skills. Learning activities: 12 items specifying the learning activities learners should actively engage in to help become self-directed learners. Evaluation: 12 items revealing learners' specific attributes that help them monitor their own learning progress. Interpersonal skills: 12 items relating to learners' skills in interpersonal relationships.

Williamson (2007, p. 78) explains that the value of students' responses to the SRSSDL items are "students self-assess their learning needs and instructors identify the students' areas of learning need and assist them in adopting appropriate techniques in growing their learning skills".

3.4.7.3 Self-Directed Learning Technology Scale (SDLTS)

The scale was originally developed by Teo, Tan, Lee, Chai and Koh in 2010 **(**Teo *et al.*, 2010). The Self-directed Learning with Technology Scale was created with a focus on adolescents and technology use. Teo *et al*'s study in 2010 examined a number of scales and tools for measuring SDL and found that few, if any, were made for use by young students. Moreover, no scales that included technology as a component to facilitate self-directed learning could be found. They then created the SDLTS to evaluate students' use of self-directed learning with a particular technology component.

The SDLTS integrate technology into self-directed learning and are more suited for younger students. The SDLTS thus provides an alternative to current self-directed learning measures, many of which were created for older students and did not take into account technology. The SDLTS assesses students' opinions of their self-management and intentional learning. Self-management, according to Teo *et al.* (2010, p. 1767), "is the capacity and willingness to direct one's own learning". One who is self-educating may independently plan and manage their time and task. Self-directed learners make decisions by carefully weighing their options. On the other hand, intentional learning refers to the quest for information done with the individual's full consent. Table 3.3 depicts the two factors and their sub factors.

3.5 The conceptual framework

The following section introduces a conceptual model for understanding Moodle SDL in an online context (see Figure 3.5).

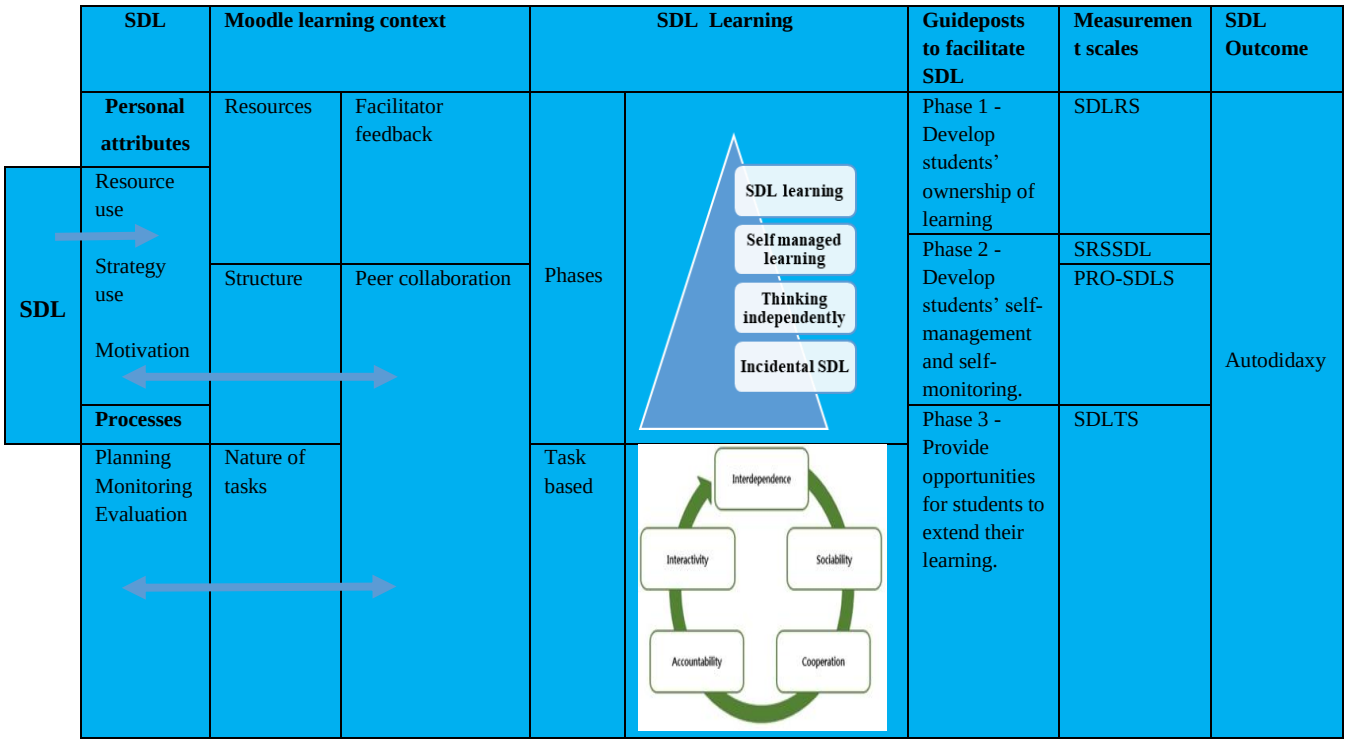


Figure 3.5: The conceptual framework

The focus of this study was to understand how Moodle promotes self-directed learning. It was therefore important for this study to explore both Moodle and self-directed learning variables. There was a need to understand Moodle learning within the context of SDL. This study's conceptual framework is therefore based on the literature review with special focus on how SDL is conceptualised within an online context. The researcher designed this framework from various literature relating to Moodle and self-directed learning. The conceptual framework consists of key concepts that helped to research and answer the research questions. This conceptual framework provides a structure that is employed in this study to help respond to the research questions**.** A conceptual framework is defined by Maxwell (2005, p. 33) as:

> …a system of concepts, assumptions, expectations, beliefs and theories that support and inform your research**.**

As a result, a conceptual framework is essentially a way to represent the phenomena being examined, in this case, the self-directed learning readiness of first year university students. The

conceptual framework that directed the research design, data collection, and analysis is discussed and presented below by the researcher.

This study is about Moodle self-directed learning. From the literature review that was discussed above, the researcher identified concepts that are important for assisting students in becoming self-directed. The researcher presents these concepts and the relationship among them in the form of a diagram (Figure 3.10) that illustrates the conceptual framework for this study. The framework shows a relationship that exists between SDL and Moodle teaching and learning.

This conceptual framework is divided into six sections, namely SDL, Moodle learning context, SDL learning, Guideposts to facilitate SDL, SDL measurement scales, and SDL outcome. These are the key concepts in which this study is embedded. This conceptual framework reflects the literature's views on SDL and Moodle. This conceptual framework shows that we first need to understand how SDL is conceptualised. Understanding the meaning of SDL will assist in achieving the ultimate outcome of SDL. The literature contains a wide range of perspectives on self-directed learning. According to some researchers, self-directed learning is a process (Guglielmino, 2013; Knowles, 1975; Van der Walt, 2016), other group of researchers advocate that it is a learner characteristic (Brockett & Hiemstra, 2010; Loyens *et al*., 2008) whereas others describe it as a design characteristic of the learning environment (Song & Hill, 2007; Jaleel & Anuroofa, 2017). Hence, any SDL contains three basic components: a process, a person, and a context. Brockett & Hiemstra (2010) provides the following explanations of these views:

> …The process involves the sequence of events that a learner experiences when taking responsibility for personal learning. The person refers to personal skills and abilities that enable a learner to learn independently. The context deals with factors surrounding the learning experience in its setting.

SDL is shown in this conceptual framework as a process in which students take charge of the instructional steps, including planning, carrying out, and assessing learning. This is consistent with Knowles' most popular definition of SDL from 1975. Knowles (1975) defines SDL as

> …process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies and evaluating learning outcomes.

Furthermore, this conceptual framework represents SDL as learner characteristics. These personal attributes include resource use, strategy use and motivation. According to studies, a

learner's level of self-direction is significantly influenced by their personality, which includes their motivational, self-monitoring, self-management, and self-control abilities (Du Toit-Brits & Van Zyl, 2017). Resources come in a variety of shapes, including but not limited to human and informational resources. Although there is an unlimited amount of information available on the internet, the gathering of good quality information resources might be a difficulty to learners. Students must assess the credibility and validity of the sources they use due to the variety of information available online. In an online learning environment, students must be aware of and actively explore a variety of learning resources. In this regard, Song and Hill (2007) argue that:

> …in order for students to exercise greater judgment and assess whether the information they have gotten is trustworthy and still valid, it is crucial to teach them to pay attention to the sources and the date of the material.

Students must devise plans for utilizing materials wisely and overcoming difficulties that are specific to online learning. In terms of strategy use, successful learning in every learning environment involves the use of effective learning strategies. Students must develop communication techniques more appropriate for the online learning environment.

Motivation has a crucial role in SDL. According to research, in order for students to contribute cognitively complex communications in online contexts, they must be encouraged to do so (Song & Hill, 2007). According to Garrison (1997), motivation is crucial for the start and continuation of effort toward learning and the accomplishment of cognitive goals. He claims that when learning is first started, motivation reflects perceived worth and expected success of learning goals. Throughout the learning process, this acts as a mediator between context (control) and cognition (responsibility). In this model, motivation has two dimensions: task motivation and entering motivation. While task motivation keeps students on track and enduring in their studies, entering motivation is what propels students to engage in the learning process (Garrison, 1997). The process of choosing goals and the decision to participate determine the student's initial state of motivation. Students' starting motivated states will be substantially greater if they think the learning goals will suit their learning demands and that those goals are doable.

As indicated in the subsection 3.3.1.1 above, SDL is conceptualised as a process. The processes refer to:

> …students' autonomous learning processes which is specifically and primarily manifested in planning, monitoring and evaluating one's own learning (Song & Hill, 2007).

Online instruction gives students the planning freedom to set their own study paces. Compared to face-to-face instruction, online learning gives students a lot more freedom to design their own learning environment and choose their own learning time, speed, and sequence.

Monitoring plays a key role in SDL. Compared to traditional students, online students are more likely to check their understanding. The student is largely in charge of the monitoring duties. Students must determine for themselves whether they fully comprehend the material or are making progress with their course work. The level of responsibility for seeking help is also much more focused with the students because they are actively participating in monitoring the process and looking for resources to solve the situation as necessary. Students must be capable of conducting self-reflection and self-evaluation of their learning objectives and development during a unit of study in order to be successful in SDL. They should periodically speak with the facilitator, ask for input, and reflect on their accomplishments to assist this self-evaluation process. To do this, you need to ask yourself questions like how do I know I have managed to learn, am I flexible in how I apply knowledge, am I convinced of my capacity to communicate information, when do I know I have managed to learn sufficiently, when is it to reflect on MY actions, and when should I speak with the advising lecturer?

We also need to understand the Moodle learning context which will assist in achieving SDL. This study took place within an online Moodle learning context. The aim of this study was to investigate students' self-directedness within Moodle learning context. SDL is seen as a design element of a learning setting which promotes students' control over their learning (Loyens *et al*., 2008). Each SDL process takes place within a learning environment or context. Merriam *et al*., (2007) suggested that:

> … learning settings that support SDL are thought to encourage high level of expertise, in which students look for meaning in the material, as opposed to surface-level processing, in which students focus on memorizing and rehearsing.

Moodle learning context focuses on environmental factors and how those aspects effect the level of self-direction demanded from the student. The SDL experience of a student can be impacted by a variety of things in the learning situation. There are design elements and support elements. Design elements include the resources, structure, and nature of the tasks in the learning context (are called design elements). These resources might be created by the instructor as instructional support and integrated into the particular learning situation. The structure of the course may be determined by the particular learning environment, and the type of the assignments may have an impact on how much self-direction the students are expected to exercise. Garrison (1997, p. 30) claim that "another set of elements in the learning context that has an impact on a student's SDL is the support in the learning context. This support component includes constructive and informative feedback from the instructor or peer collaboration and communication".

Within the learning environment, the nature of tasks given to students plays a significant role in achieving SDL. In task-based learning, learners might come to understand that other students are not their competitors in the competitive learning process, but rather their collaborative learning partners with whom they should develop and reach their full potential as effective learners.

Facilitator feedback also plays a significant role in achieving SDL. Moodle provides several opportunities for teachers to transform from being the source of knowledge to being facilitators and role models in the process of acquiring knowledge and skills. Making ensuring that learning had taken place as opposed to merely the passive transfer of knowledge is the facilitator's responsibility in the learning process. The facilitator must be willing to give the students the chance and the assistance to take charge of their own learning if SDL is to be promoted. Support, according to Oswalt (2003), entails the knowledge, direction, and resources that the facilitator offers the learning environment. It remains the facilitator's duty to give the students the tools and scaffolding they need to interact with new and unfamiliar information and abilities.

Peer collaboration is also vital for achieving SDL in any learning situation. According to Oswalt (2003), peer-to-peer support networks or groups can promote SDL whether it occurs in a formal or informal learning setting. SDL places a strong emphasis on collaboration. Collaboration is therefore part of the SDL process. The virtual collaboration offered by the Moodle learning environment illustrates the transition from the idea of solitary learning to SDL

in a more social and networked setting with collaborative generation of knowledge and learning.

Learning is at the heart of SDL. Drawing on Gibbons' (2002) work on self-directed learning, Tan, Divaharan, Tan, and Cheah (2011) suggest that:

> …self-directed learning is better understood as a spectrum that begins from the lowest level of incidental self-directed learning to the highest level of self-directed learning.

The term spectrum refers to various levels of SDL, from fully teacher-directed learning (TDL) through SDL as previously described. The following stages or levels of movement toward SDL are included on the spectrum:

- Incidental self-directed learning: The occasional inclusion of SDL activities in otherwise teacher-directed courses or programs.
- Teaching students to think independently: Courses or programs that place a strong emphasis on the individual search for meaning through inquiry, investigation, problem-solving, and creative endeavor.
- Self-Managed Learning: Courses or programs that are delivered through self-paced learning guides that students finish on their own.
- Self-Directed Learning: Courses or programs where students choose their own objectives, create their own activities, and carry them out anyway they see fit.

The growth in knowledge, skill, or performance pursued by any person for personal motivations using any method, in any location, at any age, is therefore depicted by the spectrum as SDL. Also, it demonstrates the transition from teacher-directed to self-directed learning. The main tools for achieving SDL during learning are the tasks that are offered to students. Task-based learning should be used to teach SDL.

This study was conducted within the Moodle mathematics context. According to research, task-based teaching and learning can help students develop SDL in mathematics. Students can demonstrate their mastery of a subject through task-based performance (Pokhrel, 2015). Task-based mathematics instruction is a method of teaching that can allow students many opportunities to actively engage in conversation while they work toward a mathematical goal or finish a particular learning activity. By giving students learning tasks, this instructional strategy aims to develop their proficiency in mathematics. In the mathematics classroom, a

teacher's authority is changed to that of a learning facilitator. The development of learners' independent and self-directed learning skills is a result of this change in teacher responsibilities.

Collaboration among the peers becomes an indispensable factor in undertaking the successful completion of the given mathematics learning tasks in SDL. When group members with different learning styles actively interact with one another by sharing information in order to accomplish the same learning objectives and enjoy positive interdependence in their mutual learning, collaborative learning can be achieved for task-based mathematics learning activities. Individual learners take on greater responsibility for their own learning while fostering good interdependence. Also, through mutual scaffolding, they work to encourage and support one another as they try to fill the ZPD gap. Through completing the learning tasks, they can maximise their potential as confident and competent mathematics learners.

Through mutual cooperation and constructive interdependence in task-based learning, mathematics students can come to understand that other students in the group are not their competitors in the competitive learning activities, but rather their collaborative learning partners with whom they should develop and reach their full potential as effective learners. Students should be aware that interaction between members of the learning community can maximize each person's learning outcome. Students can comprehend the value of sociability, cooperation, accountability, and interactivity in fostering a classroom culture with positive interdependence for their success in learning by engaging in task-based mathematics learning activities.

This conceptual framework includes a guidepost which researchers have designed to guide facilitators in leading students towards SDL. These guideposts were designed in three phases. Phase 1 requires facilitators to help develop students' ownership of learning. Ownership of learning is taking charge of determining where there are learning gaps and establishing learning objectives. Due to this, educators must create lessons that encourage students to take responsibility for their learning. Du Toit-Brits (2020) emphasizes the necessity of granting students cognitive autonomy, or the ownership of the learning process where they can come up with questions and come up with solutions on their own. In order to set learning goals and help students conceptualize their task designs for their learning gaps, self-directed learning facilitates students in asking questions about their own learning gaps.

Phase 2 is about developing students' self-management and self-monitoring skills. This phase involves facilitators scaffolding students to engage in self-monitoring and management and self-monitoring. This phase therefore involves the process of managing tasks, time, and resources as well as the ongoing efforts of making improvements or taking actions to meet the learning goals. In this regard, Garrison (1997, p. 3) explains that:

> …self-management involves students taking control of the learning context to reach their learning objectives. Student control does not mean independence, but rather collaboration with other people within the context. The student does not construct meaning in isolation from the shared world.

The control over management of learning tasks is realised through a collaborative relationship between the teacher and the student. Garrison (1997, p. 3) believes that students should be presented with alternatives of how they choose to proactively carry out the learning process. Garrison acknowledges the context aspect in his concept by defining resource self-management in a specific context.

According to Garrison (1997, p. 4), self-monitoring refers to the ability of students to monitor both their cognitive and meta-cognitive processes. Self-monitoring students should therefore have the ability to:

> …exploit their own learning strategies, think about what they are thinking, take responsibility for the construction of personal meaning, be reflective and think critically, use feedback to construct meaning and take responsibility for their own learning (Garrison, 1997).

Phase 3 involves providing opportunities for students to extend their learning. Extension of learning has to do with making links across disciplines, connections between formal and informal learning as well as interests in and out of school. Facilitators create scaffolds throughout this phase to aid students in reflecting on and extending their learning. At this phase, the facilitators' role is to assist students in making connections between what they have learned and their everyday lives, so enhancing the authenticity of their learning. Howland, Jonassen and Marra (2012) argue that:

> **…**when explicating their dimensions of meaningful learning with ICT, emphasis should be on the anchoring of learning in authentic contexts and problems. This ensures that students can make real-world connections of their knowledge. Students' experience of authentic learning can be further enhanced through

> activities that help them to construct personal meaning of their knowledge, especially to find personal applications of the knowledge learnt.

The SDL experience should be planned in a way that gives students the chance to relate what they have learned in the classroom, from their readings, from other sources, to their everyday life. The activities created to aid students in extending their learning have this as their main aim. To ensure that students have achieved their SDL in learning, researchers have developed different measurement scales which were extensively discussed in section 3.3.7

The expected outcome of the whole self-directed leaning process is autodidaxy. Autodidaxy means self-teaching. The product of this whole SDL process is therefore an autodidact student. Auto- means self and didact comes from the Greek word for teach, so an autodidact is a student who is self-taught (Ben-Zaken, Avner, 2010). A self-taught student is a student that lives an intellectual life without help from a teacher, or any form of education. Successful self-teaching requires self-discipline and reflective capability. An autodidact student is therefore a student who teaches himself or herself, rather than being taught by a teacher. He or she is a student who has learned a subject without the benefit of a teacher or formal education.

The idea that the classroom setting should take into account each student's unique requirements, objectives, and interests is one of the most current developments in education. Students are given scenarios to identify their own research, questions, and expertise about the field as part of an inquiry-based learning process. Students are given greater opportunities in today's classrooms to explore and engage with knowledge through exploration learning, which has its roots in autodidacticism. Autodidacticism is therefore a complement of modern and online education. As a complement to online education, students are encouraged to be more independent and SDL oriented. Autodidaxy is manifested in the behavioural indicators of SDL. Below is a brief discussion of these behavioural indicators**.**

Desire for learning

A self-directed student has a strong desire to learn. A student who is extremely self-directed assumes responsibility for determining his or her own learning needs, setting objectives, locating the best resources, and keeping track of their progress. According to Guglielmino (2013), such a learner:

> …has a highly self-directed learner exhibits initiative, independence, and persistence in learning; accepts responsibility for his or her own learning, has a

high degree of curiosity, has a strong desire to learn, and is intrinsically motivated and sees learning as a positive path forward.

Ownership of learning

Personal accountability, according to Brockett and Hiemstra (1991, p. 27), is the "cornerstone of self-direction in learning". Self-directed learners are more likely to take personal responsibility for their education, take ownership of it, set learning objectives, and accept the results of their decisions. The drive to learn is intimately tied to the development of a sense of ownership of the learning process. Students specify, choose, and explain their own learning objectives. Also, they establish criteria, document their learning processes, push themselves, and identify learning tasks to reach their goals.

Self-management

Self-management relates to management of learning activities. Students should be able to self-plan and self-manage their time. Deci and Ryan (2012) use the term self-management to refer to the behavioural task control component of managing learning activities. Additionally, he suggests an internal cognitive dimension, which Garrison (1997) refers to as self-monitoring, that pertains to learners' thinking and monitoring of learning. It's crucial to remember that self-management is characterized by the control over outside duties and resources. Students should be able to create pertinent questions and investigations, explore a variety of options, and come to reasonable judgments. Students self-organize and manage their time, critically reflect on what they have learned, and seek out feedback from classmates and teachers to further their learning.

Self-control

Self-control is an SDL attribute that empowers the student to be in charge of their own education. Each student must exercise self-control by taking charge of their own learning. Students start practicing the skills on their own and go beyond simple imitation. The first step in helping students create their internal locus of control is to give them some control over the learning processes (Boyer, Edmondson, Artis & Fleming, 2014). Internal locus of control, as

defined by Boyer, Edmondson, Artis, and Fleming (2013), refers to learners' conviction that they have sufficient control over various aspects of their learning. If students do not think they can make wise judgments about their learning, they cannot be self-directed learners.

Self-monitoring

Self-monitoring concentrates on the students' own cognitive and metacognitive components of learning. All learning processes include cognitive processes, such as thinking, understanding the information, and incorporating new knowledge into the existing knowledge base. When a learner can reflect on their learning, this process is known as metacognition, which is also known as learning to learn. Deci and Ryan (2012), for instance, propose that one can control their learning by self-monitoring, self-evaluation, and self-reaction to their learning activities and performance. Self-monitoring involves internal cognitive processes, yet it can still be influenced by outside influences, such as feedback from a teacher or others. Students use their newly gained skills to learn beyond the material covered in the curriculum and apply what they have learned to new situations.

This framework provides a structure that is employed in this study to help respond to the research questions. The way Moodle is used in teaching and learning should influence self-directed discovery learning. This conceptual framework resonates well with the topic. It speaks to the research questions, the research problem, the research method, and design. The successful implementation of Moodle towards Mathematics self-directed learning will be informed by the Moodle usability evaluation attributes which will stimulate and trigger self-directed learning. The effectiveness of Moodle to promote self-directed learning therefore relies on Moodle usability attributes and Behavioural indicators of SDL.

3.6 Chapter conclusion

This chapter discussed Moodle and SDL, the two main concepts of this study. Literature study revealed that Moodle was originally developed using sound pedagogical principles to help teachers create online courses to encourage interaction and collaborative construction of learning content. Moodle therefore provides several opportunities for teachers to transform from being the source of knowledge to being facilitators and role models in the process of acquiring knowledge and skills.

This chapter also presented various definitions of SDL. The purpose of presenting these various SDL definitions was to show that many facets make up self-directed learning. All the facets of the definition of self-directed learning presented in this chapter are integral to this study. Students nowadays are developing in a society characterized by constant connectivity, immediate information, and evolving technology. Self-directed lifelong learners are necessary in the rapidly changing workplace and knowledge environments of the twenty-first century

The literature reviewed in this study reveals that self-directed learners should have traits such a desire for lifelong learning, a sense of responsibility for their own education, the capacity to learn how to study, the ability to read for understanding, basic numerical skills, oral and written communication skills, knowledge of and proficiency with information technologies, a wide range of strategies to ensure efficient learning, self-development abilities, and high-level thinking skills.

CHAPTER 4: THE RESEARCH METHODOLOGY

4.1 Introduction

The preceding chapter reviewed the literature on Moodle and self-directed learning. This chapter builds upon this literature review and the research objectives stated in the earlier chapters. It describes the methodology of this study. According to Creswell (2015), methodology refers to ways of obtaining, organising and analysing data. Methodology is thus focused on the description and analysis of research methods and aimed at understanding the process of scientific enquiry. Methodology thus describes the articulated, theoretical approach researchers take to gaining knowledge about the world and is informed by their philosophical position.

This chapter therefore discusses the research methods and design used in the study. This includes the strategies, instruments, and data collection and analysis methods, while also explaining the stages and processes involved in the study.

4.2 The research method

4.2.1 Definition of research methods

Creswell and Poth (2018) define the research method as the specific procedures or techniques that are used to gather data. Although research modes can be divided into numerous ways, the three most popular categories are qualitative, quantitative, and mixed approaches. A discussion of the various research methods is provided below.

4.2.2 Qualitative research methods

Researchers developed qualitative research methods in the social sciences in order to explore social and cultural phenomena. According to Creswell (2015), qualitative research is defined as an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyses words, reports detailed views of informants, and conducts the study in a natural setting.

Stake (2010) identifies four special characteristics that he attributes to qualitative research which relates to this study as illustrated in figure 4.1:

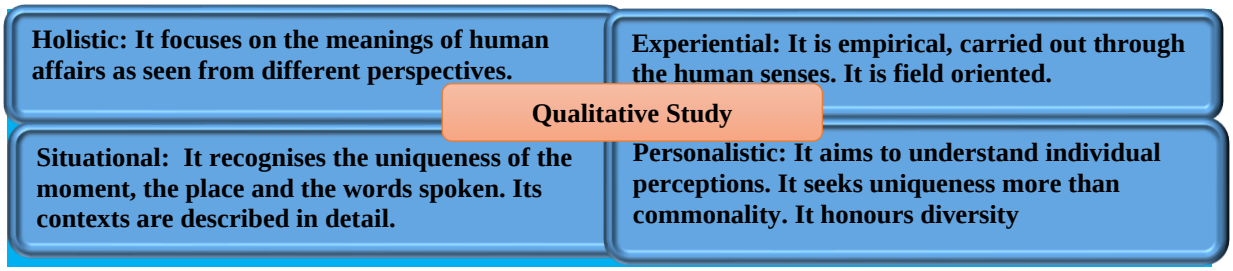


Figure 4.1: Special characteristics of a qualitative study (Stake, 2010, p. 15)

In qualitative research the researcher interacts with the selected participants in their settings to describe and analyze the participants' actions, beliefs, thoughts, and perceptions (Creswell & Poth, 2018). So, the purpose of qualitative research is to aid in the understanding of individuals and the social and cultural environments in which they live.

4.2.3 Quantitative research methods

To explore natural phenomena, quantitative research techniques were initially established in the natural sciences. Quantitative research presents statistical findings via numerical or statistical data in terms of data analysis. Quantitative research is a mode of inquiry that is frequently employed in deductive research when the objective is to test theories or hypotheses, collect descriptive data, or look at correlations between variables. These variables are measured and yield numeric data that can be analyzed statistically. Quantitative data therefore "have the potential to provide measurable evidence, to help to establish (probable) cause and effect, to yield efficient data collection procedures, to create the possibility of replication and generalization to a population, to facilitate the comparison of groups, and to provide insight into a breadth of experiences" (Johnson & Christensen, 2020, p. 608).

4.2.4 Mixed methods research

According to Creswell (2015, p. 203), mixed method research "was born out of the belief that all methods have limitations and the view that biases from any single method could neutralize or cancel the biases of other methods which further herald triangulation of data sources as a means of convergence, connection or embedded to the integration of quantitative and qualitative data". Due to this, scholars from all over the world have created a variety of mixed strategy approaches. In order to reduce the flaws of both in individual research studies as well as across mixed studies, mixed method research acknowledges that both quantitative and qualitative research methods are valuable and significant. Rather than attempting to replace either, it draws on each's strengths.

There are numerous definitions of mixed methods throughout the literature. According to Johnson and Christensen (2020, p. 32), the term mixed methods research "generally refers the type of research in which a researcher, or a team of researchers, integrates qualitative and quantitative research approaches within a single study or a set of closely related studies". An additional definition of mixed methods "is an approach to research in the social, behavioural, and health sciences where the researcher collects both quantitative (closed-ended) and qualitative (open-ended) data, combines the two, and then develops interpretations based on the strengths of both sets of data to comprehend research problems" (Creswell, 2015, p. 2).

Researchers mix parts of qualitative and quantitative research methodologies for the general purposes of gaining a broad and deep understanding as well as for corroboration. As a result, mixed methods research "entails the purposeful gathering of both quantitative and qualitative data as well as the combining of each to address research objectives (Johnson & Christensen, 2020). Quantitative and qualitative methods work best when combined in a single study because they enable a more thorough investigation of the research problem. The strategies are complementary rather than competitive methods.

4.2.5 The methodological choice of this study

The researcher's belief is that it was not enough to understand and access the truth about the phenomenon under study solely by virtue of a single scientific method. For the researcher, a mono-methodological orientation of research was not good enough. Rather, the researcher opted for a methodology "which would provide methods of research that are seen to be most

appropriate for studying the phenomenon at hand" (Johnson & Christensen, 2020. p. 34). In order to shed light on participants' actual behaviour, the beliefs that underlie those behaviours, and the outcomes that are likely to result from various behaviours, the researcher looked for research approaches that could be more practical and pluralistic approaches that could allow a combination of methods. As a result, an approach that promotes the usage of mixed methodologies was chosen.

Based on the research questions and data collection instruments (Questionnaires which are in a Likert scale format and interviews), the mixed method research is the preferred method of this study. The researcher, therefore, chose mixed methods research because it combines elements of qualitative and quantitative research approaches. This gave this research broad purposes of breadth and depth of understanding and corroboration. For the sake of complementarity, mixed research methodologies were chosen. The aim was to use a variety of approaches to evaluate various aspects of students' SDL in order to develop a more thorough understanding of Moodle self-directed learning. As different aspects of a SDL were examined using a variety of ways, a more thorough understanding developed as the outcomes of one method enhanced, elaborated, clarified, or complemented the outcomes of the other.

For the purpose of confirmation, the researcher also selected mixed method research. The desire to compare results from one type of data with those from another type of data has driven many recent investigations. Researchers use this technique, also known as triangulation, to measure the same phenomenon by gathering many types of data (Creswell & Creswell, 2018).

To enhance and enrich the significance of a single perspective, the researcher also used the mixed method approach to look at the research problem from various angles. The researcher also wanted to contextualise information, to take a macro picture of a system and add in information about individuals. The researcher was therefore interested in "merging quantitative and qualitative data to develop a more complete understanding of a problem; to develop a complementary picture; to compare, validate, or triangulate results; to provide illustrations of context for trends; or to examine processes/experiences along with outcomes" (Creswell & Plano Clark, 2018, p. 221).

The ability for one database to build on another was another factor in the decision to use mixed methods research. When the qualitative phase is conducted after the quantitative phase, the goal may be to clarify the process underlying the quantitative results or to choose the most suitable participants for follow-up. This helps "to discover and to handle threats for validity arising from the use of qualitative or quantitative research by applying methods from the alternative methodological tradition and can thus ensure good scientific practice by enhancing the validity of methods and research findings" (Johnson & Christensen, 2020, p. 487).

By relating complimentary findings that come from the application of methodologies from the different methodological traditions of qualitative and quantitative research to one another, this approach also helps to get a richer picture and deeper knowledge of the subject being studied.

4.3 The research design

4.3.1 Definition of a research design

Creswell (2015, p. 97) conceptualise the research design as "a road map of how the research will be conducted. It includes the method to be used, the data to be collected, where, how and from whom the information will be collected as well as the circumstances under which the information will be collected". On the other hand, Creswell and Plano Clark (2018, p. 64) define a research design as "a plan and structure of the inquiry utilized to gather the data necessary to respond to the research question". A research design, then, consists of plans, tactics, and processes for study that include choices for everything from the underlying worldviews to the specific techniques for gathering and analyzing data.

Johnson and Christensen (2020, p. 488) claim that "the purpose of the research design is to plan, structure, and carry out the research in a way that maximizes the validity of the results". This is alluded to by Creswell (2015) and Poth (2018), who claimed that a research design encompasses a variety of elements, such as knowledge of the methodology, tools for gathering data, improvement of quality, ethical issues, and data analysis. The main purpose of research design is therefore "to ensure that the data which is collected and analysed does in fact answer the initial research questions. It also helps to address the research questions which will ultimately result in the designing of a suitable methodology to gather data" (Johnson & Christensen, 2020, p. 488).

Creswell (2015, p. 98) argue that "the researcher's worldview assumptions, personal experiences, study audiences, the nature of the research topic, research strategy, and techniques of data collection, analysis, and interpretation all have an impact on the choice of a particular research design". According to Creswell and Plano Clark (2018), there are six mixed method designs that are frequently employed in academic studies. The designs are the multiphase design, the embedded design, the transformational design, the explanatory sequential design, and the convergent parallel design.

4.3.2 The convergent parallel design

In a convergent (or parallel or contemporaneous) mixed methods approach, data from both quantitative and qualitative sources are simultaneously gathered, combined, and used to understand a study problem (Johnson & Christensen, 2020). For instance, to better understand participants' experiences with a health passing mathematics, a researcher might gather both quantitative correlational data and qualitative individual or group interview data and mix the two. Data analysis entails combining data and contrasting the outcomes of the two sets of analysis.

4.3.3 The explanatory sequential design

The mixed-methods researcher prioritizes gathering and analyzing quantitative data (Creswell & Creswell, 2018). First in the series, the mixed-methods researcher gathers quantitative data. The secondary qualitative data collection technique comes next. The conclusions from the quantitative data are refined by the mixed methods researcher using the qualitative data.

4.3.4 The exploratory sequential design

The mixed-methods researcher first collects qualitative data to investigate a phenomenon and then quantitative data to clarify relationships revealed by the qualitative data (Johnson & Christensen, 2020). The mixed methods researcher places more emphasis on qualitative data than quantitative data.

4.3.5 The embedded design

Both quantitative and qualitative data are gathered by the mixed-methods researcher either concurrently or sequentially. Throughout the study, both types of data are gathered roughly at the same time or in order (Creswell & Plano Clark, 2018). The mixed-methods researcher

employs the secondary form of data to supplement or supply extra sources of data that the primary source of data does not offer.

4.3.6 The transformative design

Either a convergent, explanatory, exploratory, or embedding design is employed by the mixed methods researcher. As an organizing principle for the entire study, the transformative design uses a theoretical framework (such as a feminist perspective or a racial or ethnic perspective) (Creswell & Plano Clark, 2018). The mixed-methods researcher urges action to address the social problem the group under investigation is dealing with.

4.3.7 The multiphase design

When researchers or a group of researchers explore an issue or topic across a number of phases or independent investigations, this is known as a multiphase mixed methods design (Creswell & Creswell, 2018). A multiphase design results from numerous initiatives carried out over time that are connected by a shared goal.

4.3.8 The design choice of this study

In various study stages or projects, mixed method researchers employ a convergent, explanatory, exploratory, or embedded design. The focus of my study was on abstract aspects of self-directed learning which can only be inferred from observable practices and propositions that participants in the study advance. This study explored the experiences and practices from the perspective of participants. It sought to establish and understand the perspectives on Moodle self-directed learning. This study therefore used an explanatory sequential mixed method design. The sequential flow of the quantitative and qualitative phases is shown in figure 4.2:

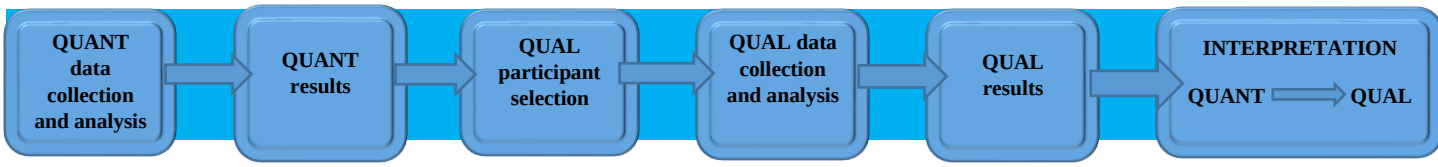


Figure 4.2: Explanatory Sequential Mixed Method Design (Source: Creswell & Plano-Clark, 2011)

According to Creswell and Plano Clarke (2011, p. 86), "the explanatory sequential mixed-methods design consists of two distinct phases". The researcher collects and analyses the

quantitative data as phase one. In the second qualitative phase, the researcher builds on the results of the quantitative data.

The study's sequential design allowed the quantitative data to act as a foundation for the qualitative data that came after. The quantitative data and analysis were initially more heavily weighted in this two-phase, single study, sequential approach; however, the qualitative data were later used to explain, refine, and elaborate the quantitative conclusions. A mixed methods approach allowed for a deeper comprehension of the study issue and a richer analysis resulting from the utilization of both quantitative and qualitative data. This strategy was chosen because it allows for additional in-depth analysis, specifically through the collection of qualitative data, to be done in order to clarify, extend, or explain the broad picture that the quantitative data and results provide of the study problem.

4.4 The research paradigm

4.4.1 Definition of a paradigm

The term paradigm originated from "the Greek word *paradeigma* which means *pattern,* model, or example" (Mackenzie & Knipe, 2006). It was first used by Kuhn to refer to a conceptual framework accepted by a community of scientists that gave them a useful framework for analyzing issues and coming up with answers (Kuhn, 1974). According to Kuhn (1970, p. 146), a paradigm is an "the entire constellation of beliefs, values, techniques, and so on shared by members of a given [scientific] community". A paradigm is an integrated group of important concepts, factors, and issues that are connected to related methodological methods and tools. Contrarily, Morgan (2007, p. 61) describes the term paradigm as "a research culture with a shared set of views, values, and assumptions about the purpose and methodology of research". Hence, a paradigm denotes a framework, pattern, or system of beliefs, principles, and presumptions in science and academia.

The term paradigm in educational research refers, according to Johnson and Christensen (2020), to a framework that establishes how knowledge is investigated and understood as well as the driving force and objective of the research. So, knowing the research paradigm helps researchers have a better understanding of what goes into conducting research. This implies that the type of methodology that will guide the study process is determined by paradigms. In

light of this, the researcher contends that using a certain research paradigm to frame investigations provides researchers with theoretical, methodological, and practical guidance for creating and carrying out research.

4.4.2 The essential elements of a research paradigm

Regarding the fundamental components of a paradigm, Creswell (2015, p. 102) claims that "a paradigm has four elements, namely, epistemology (how do you know something), ontology (what is reality), methodology (how do you go about finding out), and axiology (ethical issues)". Figure 4.3 explains the above terms and the relationship between them:

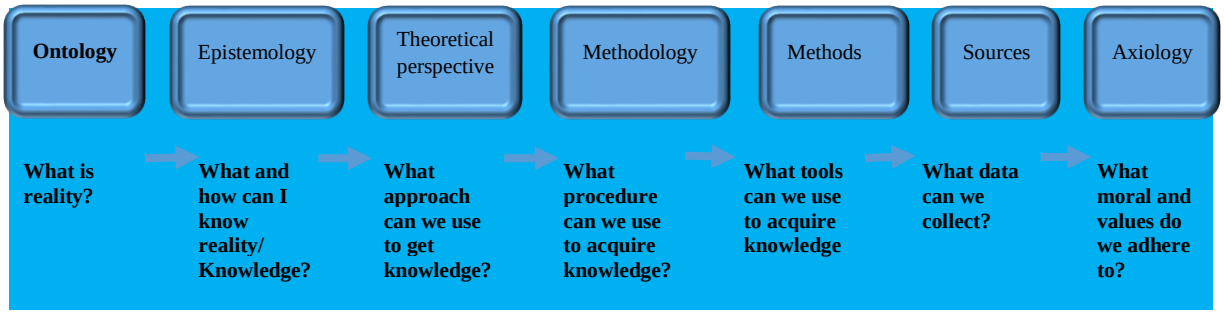


Figure 4.3: The essential elements of a research paradigm

4.4.2.1 Ontology of a paradigm

Ontology is defined "as a branch of philosophy that "is focused on the presumptions that researchers use to determine if something makes sense or is real, as well as the very character or substance of the social phenomenon they are examining" (Richards, 2003, p. 33). It is the philosophical examination of the nature of reality, being, and becoming, as well as the fundamental types of existing entities and their relationships. It looks at the researcher's underlying assumptions regarding the nature of existence and being. Ontology helps researchers in conceptualizing the shape, type, and extent of knowledge that they hold about reality.

Understanding how researchers interpret the data they collect requires a knowledge of philosophical assumptions about the nature of reality. These presumptions, conceptions, or assertions direct their thinking about the research topic, its importance, and the approaches that might be taken to aid in its resolution. Ontology is crucial to a paradigm because it contributes to a better knowledge of the elements that make up the known world (Creswell & Creswell, 2018). It aims to identify the true essence, or the fundamental ideas that underlie the themes

that researchers examine to make sense of the significance contained in study findings. It prompts researchers to consider questions like: Does the social world actually exist, or is it merely a mental construct? What kind of thing is reality? In other words, is reality a product of individual intellect or is it of an objective nature? What type of situation is being investigated?

4.4.2.2 Epistemology of a paradigm

The Greek word episteme, which signifies knowledge, is where the term epistemology first appeared (Creswell & Poth, 2018). Epistemology is a term used in research to describe how researchers come to know something, how they understand reality or truth, and what constitutes knowledge in the real world.

It is concerned with the very foundations of knowledge, including its nature, forms, modes of acquisition, and methods for disseminating it to other people. It focuses on the types of human knowledge and cognition that scholars might be able to pick up in order to deepen, expand, and extend their grasp of their particular subject of study. Cohen, Manion, & Morrison (2011, p. 7) define it "as the study of the nature of knowledge and justification". As a result, when thinking about the epistemology of their research, researchers ask themselves things like: Is knowledge something that can be acquired, or is it something that must be directly experienced? What are the characteristics of knowledge and how do the knower and the would-be known relate to one another? What connection exists between what is known and me, the questioner? These questions are crucial because they assist researchers in establishing their position within the study context so that they can identify what else is novel in light of the existing body of knowledge.

4.4.2.3 Methodology of a paradigm

A paradigm's methodology relates to how the researcher accesses and communicates what is discovered about reality. A paradigm's methodology focuses on how researchers understand the world or gain knowledge about part of it (Yin, 2016). Researchers should ask themselves the following question when they examine the methodology paradigm for their research: How shall I go about getting the desired data, information, and understandings that will enable me to answer my research question and so add to knowledge? A paradigm directs researchers to pose certain questions and employ suitable methodologies for systematic inquiry, or how to examine the world.

4.4.2.4 Axiology of a paradigm

The term axiology refers to “the moral concerns that must be taken into account when designing a study” and answers the question, "What is the nature of ethics or ethical behaviour?" (Patton, 2002, p. 134). The respect for human values of each person who will be participating in or participate in a study project must be taken into account in order to provide a satisfactory answer to this question. According to (Patton, 2002, p. 134), this consideration is facilitated by asking questions like “What values will researchers live by or be guided by as they conduct their research? What ought to be done to respect all participants’ rights? What are the moral issues and characteristics that need to be considered? Which cultural, intercultural, and moral issues arise and how will researchers address them? How shall researchers secure the goodwill of participants? How shall researchers conduct the research in a socially just, respectful, and peaceful manner? How can researchers minimize or eliminate risk, whether it be legal, social, economic, psychological, or any other kind?”.

Belak and Rozman (2012, p. 1612) argue that “four standards of ethical conduct—teleology, deontology, morality, and fairness—serve as the finest guides for finding the answers to these questions”. They define the four standards as follows:

> …Teleology is the term used to describe efforts undertaken in research to ensure that the findings have a purpose and will please as many people as possible. Deontology is the belief that each decision made during a research project will have an effect that is intended to benefit the participants, the researcher, the academic community, or the general public. The morality criterion refers to the fundamental moral principles that the study would uphold (Belak & Rozman, 2012).

For instance, that the researcher will interpret the data accurately. The fairness criterion also emphasizes to the researcher the importance of being fair to all research participants and upholding their rights. How fair will my research actions be? is only one example of a question that helps to guide implementation of this criterion. Will they treat every research subject equally? Do my activities favor or discriminate against any of the participants?

4.4.3 Discussion of the different paradigms

Johnson and Christensen (2020) identified five most used paradigms in educational research, namely positivism, postpositivism, transformative/ emancipatory, interpretivism and pragmatism. Below is a brief discussion of these paradigms.

4.4.3.1 Positivism

Positivism is a paradigm for natural sciences that takes a scientific stance toward research that primarily employs a quantitative method (Creswell, 2015). It is not based on conjecture, but rather on things that can be observed or demonstrated. To advance science, positivism emphasizes the study of observable behaviour. According to this paradigm, the development of knowledge in a social setting can be discovered by conducting scientific analyses of hypotheses, experiments, and quantitative data (Creswell & Plano Clark, 2018). Hence, positivists analyze data using statistical methods and make generalisations about their findings. As a result, data are statistically analyzed and typically displayed in a statistical table.

4.4.3.2 Postpositivism

Quantitative data analysis and data collection techniques are related to the postpositivist paradigm. According to postpositivists, knowledge can only be known in an imperfect and probabilistic way. Postpositivists, according to Creswell and Creswell (2018), believe that human knowledge is conjectural and not founded on unquestionable, indisputable facts. The postpositivist paradigm focuses on attempting to recreate the subject through the text rather than becoming stuck on the assurance of objectivity (Johnson & Christensen, 2020). This research paradigm makes the assumption that knowledge is never static and is constantly evolving (Creswell & Plano Clark, 2018). There is simply an estimate of reality. It is not fixed.

4.4.3.3 Transformative

The transformative paradigm "grounds its study in social justice issues in order to address the political, social, and economic problems that cause social oppression, conflict, struggle, and power structures at whatever levels they may arise" (Kivunja & Kuyini, 2017, p. 35). It aims to alter politics in order to address social oppression and enhance social justice in the circumstance. This paradigm presupposes a dialogic approach, an axiology that respects cultural norms, a transactional epistemology (in which the researcher engages with the participants), and an ontology of historical realism, particularly as it relates to oppression.

Action research that is transformative or emancipatory employs a mix of quantitative and qualitative methods. The central tenet of the transformative paradigm, according to Kivunja and Kuyini (2017), is to prioritize the lives and experiences of the oppressed and discriminated against in order to improve social justice. However, the transformative paradigm places less emphasis on ontology and is less able to offer guidance on methodology.

4.4.3.4 The interpretive paradigm

Interpretivism is mostly utilized in qualitative research since it focuses on analyzing social behaviours through the gathering, analysis, and interpretation of text (Miles, Huberman & Saldaña, 2014). According to the interpretive paradigm, human experiences in the subjective world are where truth is intrinsically founded.

According to interpretivism, knowledge is founded on observable events, individual convictions, standards, and understanding (Yin, 2014). According to Miles, Huberman, and Saldaña (2014, p. 71), interpretivism holds that "knowledge of reality can only be attained through social constructs and that, the interpretivist approach relies on observations, interviews, and study of the body of literature to create a meaningful reality".

According to the interpretive paradigm, people have a propensity to provide meaning to their behaviour, acts, and experiences (Yin, 2014). In order to interpret human experiences, researchers need their own prior knowledge. The participant interpretations are compared to the researcher's interpretations, and a strong level of argumentation is used to support both. According to Yin (2014), knowledge is created through interactions between researchers and participants who analyse their own actions and routines in light of how they interpret their sociocultural contexts. To avoid creating their own perceptions, this requires researchers to look at circumstances through the participants' eyes.

4.4.3.5 Pragmatism

This paradigm was developed by philosophers who argued that neither it was possible to ascertain social reality as it was created under the interpretivism paradigm, nor was it possible to access the truth about the real world solely by virtue of a single scientific method as advocated by the positivist paradigm (Cohen, Manion, & Morrison, 2011). A single paradigmatic direction for study was insufficient for them. Instead, these philosophers asserted that "what was required was a worldview that would provide research methodologies that are perceived as being most appropriate for analyzing the issue at hand" (Morgan 2007, p. 61). In

order to shed light on participants' actual behaviour, the beliefs that underlie those behaviours, and the consequences that are likely to result from various behaviours, these theorists searched for research approaches that could be more practical and pluralistic approaches that could allow a combination of methods.

This led to the development of the pragmatic paradigm, which promotes the use of mixed methodologies as a pragmatic approach to understanding human behaviour. Methodological purists' assertions that qualitative and quantitative research represent two distinct worlds that cannot be combined are disputed by pragmatic theory. Instead, pragmatism sees the various ways as complimentary and interdependent given their own strengths and weaknesses, with the benefits of combining methods outweighing any possible drawbacks. This paradigm promotes "a relational epistemology (what the researcher deems significant to that study will define relationships in research the best), a non-singular reality ontology (as there are many different realities, each person's perception of reality is distinct), a mixed methods methodology (a method that combines quantitative and qualitative research), and a value-laden axiology (doing studies that benefit people)" (Johnson & Christensen, 2020, p. 489). Both objective and subjective information are valued in pragmatics. Instead of examining the nature of knowledge, this paradigm is focused on understanding problems that exist in the real world.

4.4.4 The paradigm that informed this study

The pragmatic paradigm, according to the majority of academics, provides the philosophical foundation for mixed methodologies designs that put an emphasis on letting the nature of the research questions guide selections concerning methods. As a result, a lot of mixed methods researchers support pragmatism as the theoretical underpinning of their work. According to Doyle, Brady, and Byrne (2009, p. 175), "the philosophical underpinning of pragmatism allows and guides mixed methods researchers to use a variety of approaches to answer research questions that cannot be addressed using a singular method. Researchers who hold that some research questions are better answered by both quantitative and qualitative data therefore tend to align themselves with the pragmatic paradigm".

As a result, in order to answer the research objectives and questions outlined in Chapter 1, the researcher needed to gather both qualitative data and quantitative data. This research aimed to understand students' perspectives on mathematics self-directed learning. In particular, the study sought to gain insight into the following main research question: What relationship exists

between Moodle Learning Management system and students' self-directed learning. This was achieved by answering the following questions.

Main research question: What relationship exists between Moodle Learning Management system and students' self-directed learning.

Sub-research questions

Research Question 1: How do students use Moodle Learning Management system for self-directed learning?
Research Question 2: To what extent do students perceive themselves to have the necessary skills to use Moodle for mathematics self-directed learning?
Research Question 3: After using Moodle, how do students perceive the improvement of their Mathematics self-directed skills?
Research Question 4: How do students perceive the usefulness, effectiveness, and ease of use of Moodle?

To accomplish the stated research goals, the aforementioned research questions necessitate the use of research techniques and instruments that are likely to produce valuable data, both qualitative and quantitative. Additionally, this necessitates the use of an appropriate research design that takes into account a variety of methodological factors, such as research philosophies, research methods, and study design. Pragmatism was chosen as the preferable paradigm because of these factors. Pragmatist researchers use a combination of qualitative and quantitative data collection methods and data because it helps them better grasp social reality (Mertens, 2012). The alternative paradigm that mixed methods researchers most usually base their work on is pragmatism. Pragmatism is at the heart of mixed methods research, which promotes the use of several world views.

4.5 Population and sampling

According to Creswell and Creswell (2018), a research population is generally a large collection of individuals that is the main focus of scientific enquiry. A population is often referred to as a clearly defined group of people or things that are recognized to share certain traits. As a result, the term target population refers to "a sample a group of selected people

chosen for participation in a study or a group of relatively smaller number of people selected from a population for investigation purpose" (Johnson & Christensen, 2020, p. 271). The target population for this study was the first year Diploma in Agriculture students at a South African university (n = 250).

4.5.1 The questionnaire sample

This study is based on mixed methods research. Mixed methods sampling requires an "understanding and acknowledgement of sampling strategies that occur in quantitative and qualitative research" (Johnson & Christensen, 2020, p. 53). In order to generate a sample that most closely represents the complete population, probability sampling techniques are most frequently utilized in quantitative research. Primarily in qualitative research, purposeful sampling strategies are employed to choose participants or other study units that can produce data that will answer the research questions (Creswell & Creswell, 2018). Purposive and probability sampling characteristics are therefore both present in mixed methods sampling. The design of this study is explanatory sequential, as stated in section 4.3.8. Researchers choose the units of analysis (such as participants) in sequential explanatory designs by sequentially employing probability and purposive sampling techniques (Creswell, 2015). Purposive sampling is used for the qualitative phase after probability sampling for the quantitative phase. Purposive sampling generates data for the qualitative phase whereas probability sampling generates data for the quantitative phase. To get two distinct sets of data, these two sampling techniques are employed.

The foundation of probability sampling is the idea that each person in a population has an equal and known chance of being chosen. 150 participants were selected through simple random sampling to collect data through questionnaires. Simple random sampling is considered by Cohen, Manion and Morrison, (2007) as a sampling procedure that ensures that all sample units in the specific population will have the same, equal, known chance of being selected. The benefits of using simple random sampling in this study were that there was no possibility of sampling biases, and the sample was a good representative of the population. The names of students were written in small pieces of papers. These papers were folded and put inside a box. Ten students in class were asked to randomly pick the names from the box. The first 150 names to be picked were chosen to participate in this study. Each student had the same probability of

being selected. 87 male (58.0%) students and 63 female (42.0%) students participated in the completion of the questionnaires. The age of respondents was between 17 and 25 years old. 57 (38.0%) of the participants were from the ages 17 to 19 years; 65 (43.3%) of the participants were from the ages 20 to 22 years; 28 (18.7%) of the participants were above 22 years.

Their biographical details are displayed in table 4.1:

Table 4.1: Participants' Biographical Details

		Frequency	Percent	Valid Percent	Cumulative Percent
Gender	**Male**	87	58.0	58.0	58.0
	Female	63	42.0	42.0	100.0
	Total	150	100.0	100.0	
Age	**17-19 Years**	57	38.0	38.0	38.0
	20-22 Years	65	43.3	43.3	81.3
	MORE THAN 22 Years	28	18.7	18.7	100.0
	Total	150	100.0	100.0	

4.5.2 The action logs sample

For action logs simple probability sampling was also used to select 10 students. Their activities on Moodle were manually gleaned.

4.5.3 The interview sample

The researcher purposely selected 5 students to take part in the interviews in order to better understand the nature of scientific inquiry, as well as to confirm probes and the students' answers to the questionnaires. The sample selection was done on the advice of Creswell and Plano Clark (2018, p. 68) suggested that "sampling size in qualitative studies is typically smaller as the researcher looks at the depth of the information gleaned from the participant, rather than to generalize a finding as in quantitative research".

Purposive sampling was suitable because it results in selecting information-rich cases for in-depth study (Cohen, Manion and Morrison, 2007). In this kind of sampling, the researcher must make arbitrary decisions about which units will best give more in-depth data for the study. The researcher purposefully chose the participants in this study based on their ability to supply the necessary data. The students were selected based on their SLDTS responses. Two students were

chosen on purpose to represent the mean, two students representing one standard deviation above the mean, and two students representing one standard deviation below the mean. Instead of focusing only on the high or low end, this selection offered a more and true depiction of the students' perspectives.

4.6 The research instruments

The researcher's ontological and epistemological beliefs led to the choice of the research instruments. Particularly, the researcher was interested in understanding students' perspectives when they learn mathematics using Moodle regarding self-directed learning. From an ontological perspective, the researcher regards students as beings in a social context and within society. The researcher holds the view that all meaningful reality is socially created, meaning that people interpret it in relation to their social environment. In terms of epistemology, the researcher makes the assumption that people construct meaning as they engage in activities rather than discovering it. The researcher is of the opinion that individuals create meaning as they interact with the continuously being interpreted outside environment. Thus, for the researcher to access aspects of knowledge relating to the research topic the researcher used questionnaires, action logs and interviews.

The researcher was able to obtain the experiences—both motivating and action-driven—that students had when using Moodle through the use of interviews, action logs, and questionnaires. The questionnaires and action logs generated this study's quantitative data. The interviews generated qualitative data. The primary data source was predominantly the students who responded to questionnaires. There were pre-evaluation and post evaluation questionnaires. These questionnaires were supported by follow up interviews.

Figure 4.4 summarises the data collection instruments:

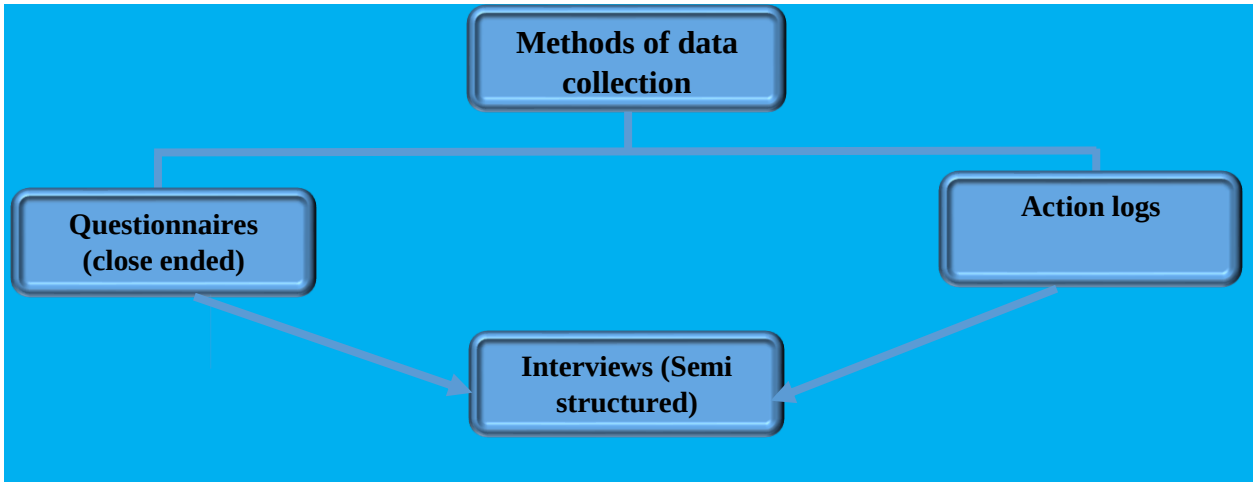


Figure 4.4: Data collection instruments and process

4.6.1 Pre evaluation questionnaires

A pre-evaluation questionnaire was the first instrument used to collect quantitative data. The aim of this pre-evaluation questionnaire was to measure the higher or lower readiness for students' SDL in ICT.

4.6.1.1 The development of the pre-evaluation questionnaire

The pre-evaluation questionnaire consisted of two sections. The first section (Appendix 3) solicited the demographic characteristics and internet experience of participants. The second section of the questionnaire (Appendix 4) was adapted from the Self-Directed Learning Readiness Scale (SDLRS) as used by Klunklin *et al*. (2010). It contained 18 items which assesses three variables, namely self-management (6 items), desire for learning (6 items) and self-control (6 items). Respondents provided their opinion about statements related to the SDLRS, ranging from '1 = strongly disagree' to '5 = strongly agree'.

4.6.1.2 Procedures for applying the pre-evaluation questionnaire

The researcher gave students hard copies which they completed to test the research assumptions. The first assumption is that most of the students are computer illiterate and have never been taught through Moodle and/or any Learning Management System. The second assumption is that students will be less self-directed, they would have been taught through traditional methods and would therefore not understand what self-directed learning is. The aim

of such a pre-evaluation questionnaire was therefore to get an insight on the students' knowledge, experience and competency of the various learning management systems and the use of other software material in teaching and learning. The researcher administered the questionnaire during the first week of the semester. 150 Diploma in plant production students were involved in the completion of this pre-evaluation questionnaire. The questionnaire was given to students to complete in class. Students were given 60 minutes to complete the questionnaires. The researcher then collected the completed questionnaires approximately 80 minutes after all participants had completed the questionnaire.

4.6.2 Post evaluation questionnaires

Two post evaluation questionnaires were used to collect quantitative data. The aim of using these questionnaires was to check the students' improvement on self-directed learning after the introduction of Moodle. These questionnaires were used to get information about students' perspectives on the use of Moodle mathematics self-directed learning.

4.6.2.1 Development of the post evaluation questionnaires

The first questionnaire, the SDLRS-SPQ (see Appendix 5) is a hybrid of Self-directed Learning Readiness Scale (SDLRS) and Self Perception Questionnaire (SPQ). This scale measured seven variables. The first three variables of instruments, namely self-management, desire for mathematics learning and self-control were derived from the SDLRS. Self-management is the phrase use to characterize the behavioural task control component of managing learning activities. Self-efficacy is a term used to describe a student's confidence (or lack thereof) in his or her ability to succeed or fail (Deci & Ryan, 2012). Desire means a strong wish to do something. Self-control in an online setting refers to the capacity to plan one's own education, adhere to long-term objectives, and fend off a variety of online diversions with little to no supervision or peer pressure (Yusuf *et al*., 2021).

The last four variables, namely the perceived usefulness, computer self-efficacy, perceived ease of use, and attitude were derived from the Students Perception Questionnaire (SPQ). This section of the questionnaire was adapted from Sanchez and Hueros (2010). The term perceived usefulness describes how much a user thinks using Moodle will help and improve his or her performance. Self-efficacy is the term used to describe users' self-assurance in their capacity to use Moodle. The term computer self-efficacy relates to how people feel they can utilize

computers to carry out tasks and produce the desired results (Karsten, Mitra & Schmidt, 2014, p. 60). Computer self-efficacy therefore refers to “assurance in one's capacity to choose the most appropriate technological solutions and apply those solutions to effectively meet learning needs in the context of self-directed use of technology for learning” (Lai *et al*., 2012, p. 55). The user's perception of how simple it is to use Moodle is indicated by perceived ease of use. The level of a user's attitude reflects how engaged they are with Moodle. Attitudinal aspects include perceptions of the worth of and emotions related to using technology for performance. The level of interest a user has in Moodle is referred to as attitude in the context of this study.

The variables of this questionnaires were measured based on metrics related to the five-point Likert scale to which users will respond to express the degree of their agreement or disagreement: 1= Strongly disagree; 2 = Disagree; 3 = Not Sure; 4 = Agree; 5 = Strongly agree. The maximum score is 190 and the minimum score is 38. High score shows positive perception towards the Moodle.

The second post evaluation questionnaire (Appendix F) was a Moodle Self-Directed Learning with Technology Scale (MSDLTS) adapted from Teo *et al*. (2010). The SDLTS is a measurement designed to evaluate younger students' use of technology in self-directed learning. Teo *et al*. (2010) claim that the SDLTS provides an alternative to self-directed learning measures that lack the technology component and were often created for older students. The SDLTS, which consists of two components, measures respondents' perceptions of their intentional learning and self-management. The SDLTS was chosen because, among other measurement methods, it incorporates technology into self-directed learning. This scale recognizes the use of technology in learning and is better suitable for younger students (Teo et al., 2010). The results from this scale may also help lecturers in establishing a learning environment that supports student self-directed learning, autonomy, and mutual responsibility. Overall, the integration of technology and the intentional development for young students make this measure the most appropriate for gathering data for the population in this study.

The variables of this questionnaires were measured based on metrics related to the five-point Likert scale to which users responded to express the degree of their agreement or disagreement: 1= Strongly disagree; 2 = Disagree; 3 = Not Sure; 4 = Agree; 5 = Strongly agree. The maximum score is 30 and the minimum score is 5. High score shows positive perception towards the Moodle.

4.6.2.2 Piloting of instruments

A pilot study can be used as a small-scale version or trial run in preparation for a major study (Yin, 2014). Pilot study is used to pre-test or try out a research instrument. To ensure the content validity the questionnaires were piloted and validated before being used in the actual study. After preparing the questionnaires, it was tested using a small group of first year students (who are not doing the same course as the one involved in this study) before being deployed to the actual sample. A sample size of 5% (n = 12) of the sample size for the actual study was used for this piloting. This was done to make sure that the questions are understandable, straightforward, and relevant. Also, it assisted in identifying unnecessary questions and enhancing the questionnaire's language. So, the goals of the pilot study were to: a) investigate and confirm the suitability of the questionnaire; and b) determine the readability and suitability of the questions. Piloting was used to determine if the items are yielding the kind of information needed. Pre-testing is a crucial step in the development of questionnaires (Plano Clark, & Ivankova, 2016). This is because piloting research instruments offers the researcher a chance to detect or identify and remove potential problems and errors prior to administering the instruments. This helps and enables the researcher to correct them. In this way, a researcher ensures that the instruments help him/her to get the required information. Piloting therefore helped to certify the validity and to identify changes needed prior to administering the instruments. The pilot study found that the questionnaires were well understood by the participants.

4.6.2.3 The reliability of the questionnaire

According to Creswell and Creswell (2018) the issues of reliability and validity should be addressed when undertaking research as data are collected, analysed and interpreted. Cronbach's alpha coefficient (Cronbach, 1951) was used as a test the reliability of this instrument (see table 4.2). George and Mallery (2003, p. 231) give the accompanying general guidelines for Cronbach's unwavering quality measurements: "> 0.9 = Excellent, > 0.8 = Good, > 0.7 = Acceptable, > 0.6 = Questionable, > 0.5 = Poor, and < 0.5 = Unacceptable". According to Santos (1999), an instrument's reliability increases with the Cronbach value. A score of 0.7 is designated as an appropriate reliability coefficient for Cronbach's Alpha. The average Cronbach alpha for the two questionnaires in this study was determined and was found to be above 0.74. (see table 4.3). Given that a reliability coefficient of 0.7 is considered to be acceptable, this study's coefficient implies that the data collection tool had some degree of reliability.

Table 4.2: Cronbach's alpha for reliability of the SDLRS-SPQ

Item no	Item Subscale	Cronbach's Alfa
1 - 6	Self-Management	0,92
7 - 12	Desire for Mathematical Learning	0,92
12 - 18	Self-Control	0,93
19 - 24	Perceived Usefulness	0,87
25 - 30	Computer Self-Efficacy	0,92
31 - 34	Perceived Ease of Use	0.82
35 - 38	Attitude	0.72

Table 4.3: Cronbach's alpha for reliability of the Moodle Self-Directed Learning with Technology Scale (MSDLTS) Questionnaire

Item no	Item Subscale	Cronbach's Alfa
1	Self-Management	0,85
2	Intentional learning	0,90

4.6.2.4 Procedures for applying the questionnaire

The researcher briefly explained the aim of the study, handed out the questionnaires, and informed the students that their response would be anonymous. The researcher stressed that each student should respond to each item. 150 students were given hard copies questionnaires which they completed. Students were given 60 minutes to complete the questionnaires. The researcher then collected the completed questionnaires approximately 80 minutes after all participants had completed the questionnaire.

4.6.3 Action logs

Moodle has built-in features called action logs that can produce several types of reports that can be used to track students' activities. With the aid of action logs, instructors may keep track of which materials and exercises have been used, when, and by which students. The researcher focused on Moodle action attributes in this study that were initiated by students on a variety of items that might be accessible from Moodle, including assignments, quizzes or assessments, course content, forum discussions.

Student activity logs are a crucial tool for understanding how students behave in online settings. In turn, observing behaviour patterns is a crucial step in identifying students' learning preferences. Activity logs can help "visualize the amount of time spent by students on learning

activities and resources used in online learning environments" (Ateia & Hamtini, 2016, p.14). Action logs can help detect "the students' learning styles and data from action logs can be used to help predict the student performance" (Romero, Espejo, Zafra, Romero & Ventura, 2013, p. 138). Action logs will help to determine the correlation between Moodle logins and self-directed learning.

For the action logs structure used in this study, see Appendix 7.

4.6.4 Interviews

Interviews with students were conducted to gather qualitative information. According to Creswell & Creswell (2018), the purpose of a research interview is to acquire descriptions of the interviewee's life world in order to understand the significance of described phenomena. The appeal of qualitative interviews is related to their success in giving research problems a human face (Yin, 2016). They provide a deeper comprehension of the significance of people's behaviour in each situation. They not only provide a versatile way to gather qualitative data, but also give the researcher access to all of the interview's many components, including speaking, listening, and nonverbal communication (Johnson & Christensen, 2020). These provide the kind of details that a written response might conceal. Due to the nature of interviews, it is possible for the researcher to follow up on specific participant responses, motivations, or feelings in order to better understand and record them (Creswell & Creswell, 2018). Interviews are based on "one of the fundamental assumptions of qualitative research: the perspective of the participant on the phenomenon being explored should be recorded as the participant perceives it and not as the researcher views it" (Creswell & Plano Clark, 2018, p. 215). As a result, researchers must constantly respect the participant's value and significance.

There are three primary forms of interviews, namely organized, semi-structured, and unstructured. In terms of these three primary forms of interviews, Creswell (2015) argues that:

> …these three interview types can be thought of as existing along a continuum. On one end of the continuum is the structured interview, which typically takes the form of a survey with standardized closed questions, and on the other is the unstructured interview, which has open-ended, conversational inquiries. Between these two extremes, and perhaps leaning more toward the unstructured interview end, is the semi-structured interview.

The researcher employed semi-structured interviews for this study because it was the most appropriate method for acquiring the information needed to best address the research topics. Kvale and Brinkmann (2009, p. 8) define the semi-structured interview as:

> … an interview designed to gather descriptions of the interviewee's world in order to understand the significance of the described phenomena.

Semi-structured interviews start with a set of fundamental questions and then move on to more in-depth queries. According to Johnson and Christensen (2020), researchers employ semi-structured interview questions to elicit detailed responses from participants about the topic under investigation. Consequently, it is necessary to carefully develop the collection of questions and to follow up in an open-ended manner in order to obtain detailed information regarding the topics of study. Researchers have a chance to probe deeper into the participants' social and personal lives through the semi-structured interviews. Moreover, semi-structured interviews are made to probe people's attitudes, beliefs, feelings, and perceptions, as well as concerns impacting them, in order to properly study issues (Creswell & Plano Clark, 2018).

Johnson and Christensen (2020, p. 229) have suggested that "preparing a few prompts or probing questions will enable researchers to uncover people's own knowledge, beliefs, thoughts, and feelings regarding issues affecting their lives". The researcher elaborates on the concerns, clarifies the questions, and encourages the participants in a non-threatening manner to share their thoughts, beliefs, and expertise in an open manner. This results in rich data being acquired from the issues examined.

The researcher learned a great deal about students' perspectives on Moodle as a learning management system (LMS) for encouraging self-directed learning through these semi-structured interviews with students. They helped to explain the students' opinions, feelings, attitudes, and level of self-directed learning competency in mathematics. They also helped the researcher to go deep into the students' experiences and understand how they perceived Moodle's self-directed learning. Knowledge was generated from exchanges between the researcher and the student participants using research interview questions. In order to elicit thought and generally observe the participants' thought processes in order to uncover any probable factors that may be affecting them, the researcher developed probing questions based on the students' responses. The researcher did everything he could to be as student-centered as possible, letting the students look at the issues from their own points of view. The semi-

structured interviews, which included in-depth discussions to gather the information required to support a reasonable interpretation of the students' attitudes and opinions about the subject under inquiry, were given a 20-minute time limit.

4.6.4.1 Development of the interview schedule

The researcher incorporated the suggestions from Creswell and Creswell (2018) into the design of the interview Appendix I. They advised that in order to acquire relevant information during a semi-structured interview, the researcher should use thoughtful, open-ended questions that can be investigated further. Such inquiries give the interviewer the chance to follow up and get further explanation from a subject via probing. They also advised using an interview plan to maintain continuity throughout semi-structured interviews. This schedule should include the subjects and open-ended questions the researcher wishes to address with each respondent. With each participant, it is not necessary to use the exact language and order of the questions. This gives the researcher the freedom to delve deeper and follow up on the information as it comes up in the course of the interview. In this way, semi-structured interviews empower participants to express their own viewpoints honestly and impulsively, helping to paint a more accurate picture of their understanding of the phenomenon rather than just the researcher's interpretation.

4.6.4.2 The procedure used in conducting interviews

The researcher in person conducted all students' interviews as a follow-up to get more clarity to the participants' responses on the questionnaires. Once the participants had signed the letter of informed permission, the researcher set up an interview schedule (see Appendix 8) and selected the time and location that would work best for them. The purpose of the interview was explained to the students. It was also made known to the students that the interviews were to be tape-recorded. Permission was asked to use recording devices. Cohen, Manion and Morrison (2011) highly recommend the use of an audiotape recording to catch verbal communication. To capture the entire interview situation, it is helpful to record data using an audio device. The data was kept safe and secure with great care.

During the interview, the researcher notified the students that notes of their responses will be taken. The students were given assurance that the interviews were confidential and for research purposes only. On average each student interview took between 15 and 20 minutes. Individual

interviews were audio recorded, and the recordings were verbatim transcribed. One effective method of presenting data in a text is through data transcription. The researcher then word-processed the handwritten transcription.

4.7 Data collection

Data collection was a three-step process to gather various information about the students' perspectives on Moodle in promoting mathematics self-directed learning.

Step 1: Pre evaluation

Students completed pre-evaluation questionnaires at the beginning of the calendar year, first semester.

Step 2: Students completed post evaluation questionnaires at the beginning of the second semester.

Step 3: Action logs

In October, data from students' Moodle activity logs was gathered. Moodle's structure makes it possible to regularly compile thorough activity statistics on students through its log files.

Step 4: Qualitative data collection

Interviews were conducted with six students in September. The students were selected based on their responses on the post evaluation questionnaires. Two students were randomly selected from one standard deviation from the mean, two from one standard deviation above the mean, and two from one standard deviation below the mean. This selection provided a more accurate reflection of the students' experience than concentrating solely on the high or low end.

The researcher therefore collected data using questionnaires, interviews, and action logs. According to Creswell and Creswell (2018), having multiple sources of evidence adds to a study's construct validity which is the degree to which a study measures accurately the concepts being researched is known as construct validity.

4.8 Data Analysis

4.8.1 Quantitative data analysis

4.8.1.1 Pre-evaluation Questionnaires

Statistical Package for the Social Sciences (SPSS) version 21 was used to analyze all of the data gathered from the respondents. In this study, the data were analyzed using descriptive statistical methods such mean, standard deviation, frequency, and percentage. One statistical description technique that can be applied to data analysis is the frequency percentage technique. With this method, the number of responses to each statement is converted to a percentage and displayed as a frequency table. One method of presenting data that more accurately depicts the participant evidence is to use this type of data analysis. To analyze responses to questionnaires and action logs, frequency percentage was employed. Klunklin *et al*, (2010) provided criteria to interpret this readiness as follows: 4.50 – 5.00 (highest level), 3.50 – 4.49 (high level), 2.50 – 3.49 (moderate level), 1.50 – 2.49 (low level), and 1.00 – 1.49 (lowest level).

4.8.1.2 Post-evaluation questionnaire

The researcher used the frequency percentage to analyse data from questionnaires.

4.8.1.3 Action Logs

The activity logs (see table 4.4 and Appendix 7) for each sampled student were collected and analysed using SPSS. By doing this, the researcher was analysing students' online Moodle behaviour. The data source used was the students Moodle platform activities. The focus was on the following activities:

Table 4.4: Total number of students' Moodle logins

Course/Activity logs	Number of students	Total number of action logs	Average actions per student
Online Assignment	150		
Online Quiz	150		
Questions posted	150		
Discussion Forums	150		

The most important feature of these actions is that they may be utilized as a collective representation of the various types of activities that students can engage in inside Moodle,

including accessing course information, interacting with peers, and completing assessment tests. The fundamental presumption made here is that students' behaviours reveal intentionality, which in turn reveals information about their preferred learning styles and self-directed learning. Thus, when organized according to class activities, the behaviours aid in determining if Moodle encourages Mathematics self-directed learning.

Action logs were employed by the researcher to show the participants' level of activity. The researcher was able to pinpoint the degree of activity for each individual student using these action logs. This analysis's aim was to ascertain whether or not students' Moodle action logs led to self-directed learning. This would be correlated with the findings of the interviews and questionnaires for the mathematics self-directed readiness scale. This analysis was also performed to determine how well Moodle supports self-directed learning. In chapter 5, the action logs of the students are analyzed and discussed.

4.8.2 Qualitative data analysis

The responses of students to semi-structured interviews were recorded and transcribed. Data from the emerging themes about factors that affected students' perspectives on Moodle mathematics self-directed learning were classified and analyzed into comparable categories. Thematic analysis and descriptive coding were employed. A researcher uses descriptive coding to determine the core theme of a paragraph. Each sentence, paragraph, or section has a single word or short phrase (often a noun) that serves as a descriptor. This was followed by thematic analysis. In qualitative research, thematic analysis is a typical technique for breaking down texts into codes that represent topics or concepts. It involves carefully identifying and analyzing themes or patterns from a qualitative data collection. According to Creswell & Creswell (2018), thematic analysis makes it possible to identify patterns and classify themes. Creswell and Creswell (2018) explained further that one important feature of analysing data is to have a continual reflection, asking analytical questions and making interpretive judgments of the information before reporting.

This is the fundamental part of thematic analysis. The analysis aided in the discovery of trends and emerging themes from students' responses on their views on Moodle with regard to self-directed learning in mathematics. It was assumed that every participant would be honest in their responses to all of the questions posed.

The following figure 4.5, illustrates the data-collection and analysis process employed in this study

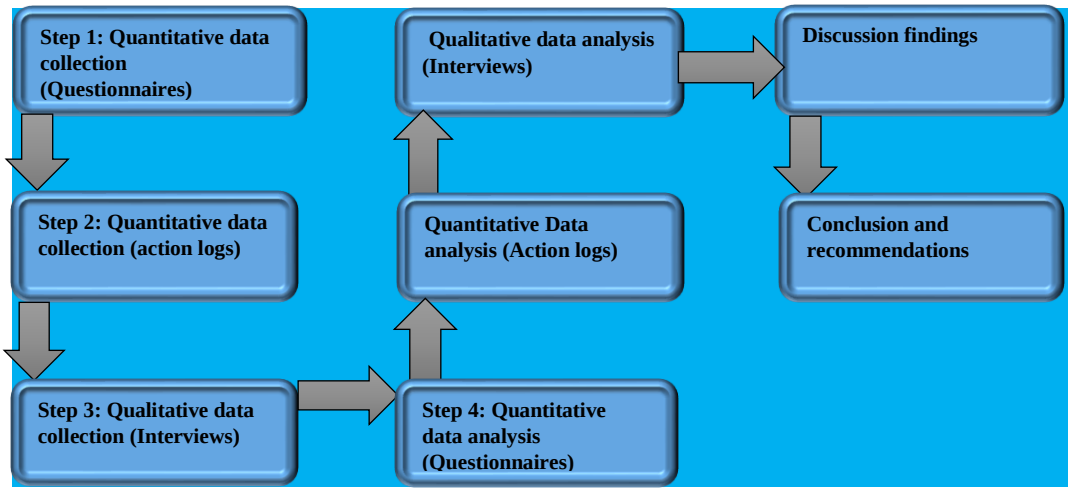


Figure 4.5: A visual representation of the whole data collection and analysis process

4.9 Reliability and validity

Most mixed methods researchers strive for validity and reliability in their work. Reliability refers to "the extent to which a particular technique, applied repeatedly to the same object, yields the same results each time or the consistency of measurement – the extent to which the results are similar over different forms of the same instrument or occasions of data collection" (Johnson & Christensen, 2020, p. 309).

According to Creswell and Creswell, (2018), reliability deals with the consistency, dependability and replicability of the results obtained from a piece of research. Gibbs (2007) suggests several procedures for ensuring reliability of findings including checking if transcripts do not contain obvious mistakes stemming from transcription, cross-checking codes developed by different researchers, making sure there is no shift in the meaning of those codes, coordinating communication among coders and sharing analysis in case it is team research. In this study, reliability was ensured by piloting the research instruments to a small sample of subjects who had quite similar characteristics to the respondents in the study. Cross-checking transcriptions and codes assisted in ensuring reliability.

Plano Clark and Ivankova (2016) view mixed-methods validity as data legitimation. According to Creswell and Plano Clark (2018, p. 221), "validity is based on determining that the findings are accurate from the standpoint of the researcher, the participant, or the readers of an account". Validity in this study was ensured through multiple validities legitimation. This was done

through triangulation. Validity was also achieved through weakness minimization legitimation. Weakness minimization was achieved by making up for the quantitative approach's flaw (respondents not completely understanding the questions in the instruments) with the qualitative approach's strength (interviewers could probe responses to ensure clarity and comprehension of questions asked). Some of the strategies used in this study to ensure validity were using member checking to determine the accuracy of information, using rich and thick description of the findings, and using an external auditor to review the whole research project. The instruments were also piloted and validated. All the interviews were transcribed.

4.10 Ethical considerations

Research in education is conducted by, with, and for people (Johnson & Christensen, 2020). As a result, ethical considerations must be made when doing educational research in order to respect and protect everyone who may be influenced by it. Whether interacting with participants or evaluating archive material, Creswell and Creswell (2018) emphasize that ethics is concerned with belief about what is right and wrong from a moral standpoint. The researcher should conscientiously protect the participants' identity and their rights. Research should also not cause harm to participants. Researchers have a responsibility to guarantee that participants' rights and interests are protected during the research endeavor (Plano Clark & Ivankova, 2016). Without carefully deliberating and actively implementing ethical principles, it is impossible to sustain the efficacy and credibility of research. Two normative systems are included in researcher ethics: one to assure proper scientific activity and the other to protect people and society as a whole (i.e., research ethics). Ethical considerations in this study were based on several issues. These include the following:

- Sensitivity to established policies and activities - The researcher pledged in the application to abide by the policies and procedures of the participating institutions for performing the research.
- Informed consent: All participants were made aware of the study's aims and methodology. Participants agreed to be audio recorded by signing consent forms and voluntarily participating in the study.
- Participant withdrawal – Participants were made aware by the researcher that they had the freedom to withdraw from the study at any moment and that doing so would not have any negative effects on them.

- Privacy, confidentiality, and anonymity: The researcher assured the participants of their anonymity and stated that only pseudonyms would be used in the writing up and presenting of the findings. The responses from the students would be handled with the utmost discretion. A code given to each participant served as a unique identifier for all data collected.
- Violation of the right to self-determination: Participants were not forced or misled into taking part in this study by the researcher.
- Ethics clearance and research permission: The researcher submitted an application for ethical approval to perform the research to the participating universities and the Wits University Human Research Ethics Committee. Together with the application was a research proposal outlining the methods, providing participants with clear information, informed consent forms, and copies of all the necessary instruments.
- Potential risk to participants: The researcher was aware that some students could feel awkward discussing their areas of weakness. Conducting interviews in private was a tactic for alleviating the situation. To reduce danger and boost interviewee confidence, one-on-one interviews were done in a private setting. The interviewee's privacy was not violated.
- Data storage: On a disk drive with a password, digital data was kept safe. The physical and digital information was kept in a secured filing cabinet. Data will be kept for five years following the thesis' publication, at which point all transcripts and field notes will be destroyed and all computer data will be removed.

4.11 Chapter conclusion

This chapter provided details of the summary of the methodology used in this study. It presented the philosophical paradigms, framework, the methods, and techniques used to collect data, the data analysis process performed as well as the ethical issues taken into consideration in the study. This is summarised in figure 4.6:

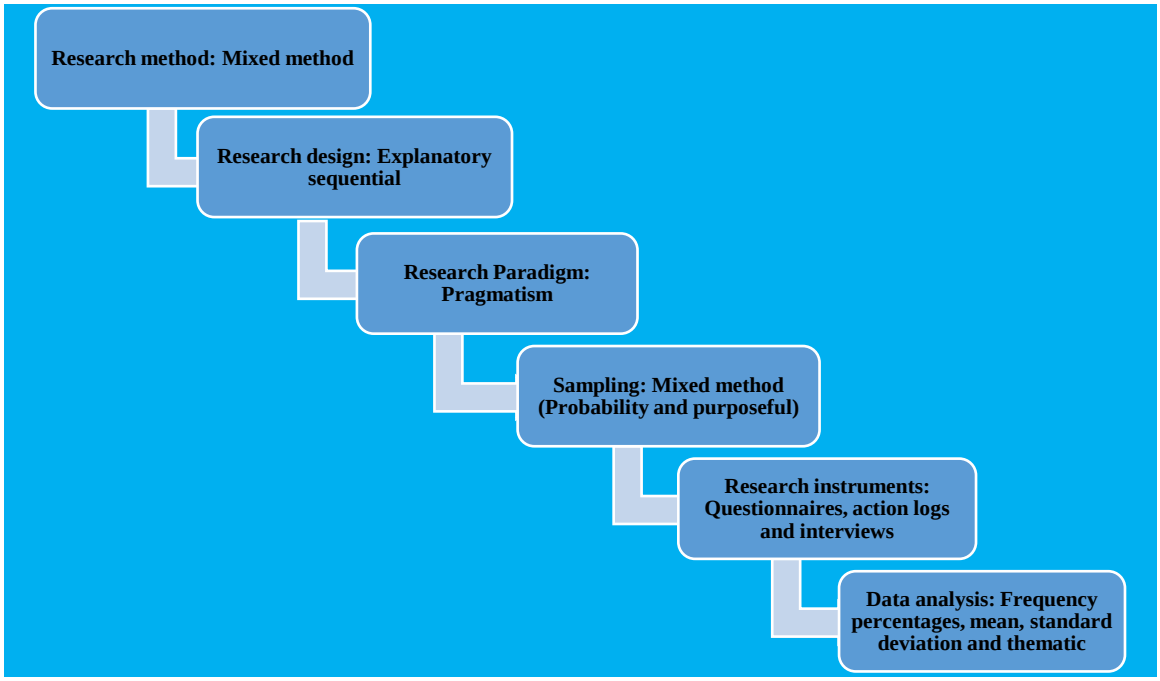


Figure 4.6: The methodology used in this study

CHAPTER 5: DATA PRESENTATION

5.1 Introduction

This chapter follows on the methodology discussed in chapter 4. This chapter presents the findings from the analysis of the quantitative and qualitative data. It also presents a descriptive and thematic analysis of the information gleaned via questionnaires, action logs, and interviews. Quantitative data were analyzed using descriptive analysis (questionnaires and action logs). This was accomplished using both the measurements of variability (the standard deviation and variance) and the measures of central tendency (the mean, median, and mode). Qualitative data were analyzed using thematic analysis (interviews). In order to provide answers to the study questions, it was essential to identify themes and patterns in the data.

There are three major sections in this chapter. The presentation of the quantitative data analysis from the pre- and post-evaluation questionnaires is included in the first part. The questionnaire results showed that each respondent had a unique and uninfluenced perspective about using Moodle for self-directed learning. The questionnaires gave reserved participants the freedom to freely share their ideas. The quantitative data analysis from the leaners' action logs is presented in the second section. Presenting qualitative data analysis from student interviews is the third and final phase. The interviews were used in the study to complement the questionnaires and action logs. To supplement the questionnaires and action logs, interviews were used in the study. As a result, the interviews made it easier to triangulate the data by using the students' action diaries and questionnaires. The subsequent next chapter will present a general discussion of the data as presented in this chapter.

5.2 Pre-evaluation questionnaires analysis

Two sections made up the pre-evaluation questionnaire. Students were questioned about their biographical information, internet and Moodle experience, and computer literacy in the first phase of the pre-evaluation questionnaire (see table 5.1). Students were required to answer questions on their readiness for academic self-directed learning using the Self-Directed Learning Readiness Scale (SDLRS) in the second section of the pre-evaluation questionnaire (see table 5.4).

5.2.1 Biographical Statistical Information

Figures 5.1 and 5.2 present the gender and age biographical statistical percentage output of the participants who completed the questionnaires.

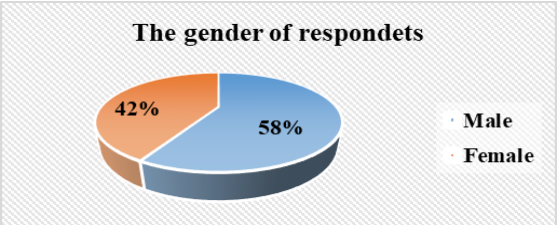


Figure 5.1: Gender of respondents

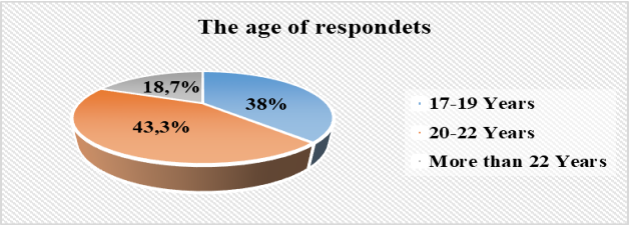


Figure 5.2: The age distribution of participants

87 male (58.0%) and 63 female (42.0%) students participated in the completion of the questionnaires. In terms of age distribution, most of the participants (43.3 %), were from the age group 20 to 22 years, followed by the ages from 17 to 19 years (38%). The least number of participants was from the age group of more than 22 years (18.7 %).

5.2.2 Moodle experience and computer literacy statistical analysis

Participants were asked about their internet experience, Moodle experience and level of computer literacy. Questions such as “Do you have computer at home? How long have you been using computer? Do you have access to the Internet? How long have you been using the Internet? How much time do you often spend on the Internet in a day?” formed part of the questionnaire that was used to generate these data. Table 5.1 displays a visual statistical output per question regarding the choices participants made on the 5- point Likert- scale.

Table 5.1: Internet Experience Frequencies

Factor	Sub factor	Frequency	Percent	Valid Percent	Cumulative Percent
Internet experience	No experience	**37**	**24.7**	**24.8**	**24.8**
	Some experience	**93**	**62.0**	**62.4**	**87.2**
	Experienced	**13**	**8.7**	**8.7**	**96.0**
	Very experienced	**6**	**4.0**	**4.0**	**100.0**
	Total	**149**	**99.3**	**100.0**	
	Missing	**1**	**.7**		
Moodle experience	No experience	**41**	**27.3**	**27.9**	**27.9**
	Some experience	**81**	**54.0**	**55.1**	**83.0**
	Experienced	**19**	**12.7**	**12.9**	**95.9**
	Very experienced	**6**	**4.0**	**4.1**	**100.0**
	Total	**147**	**98.0**	**100**	
	Missing	**3**	**2.0**		
Do you have computer at home?	Yes	**60**	**40.0**	**40.0**	**40.0**
	No	**90**	**60.0**	**60.0**	**100.0**
	Total	**150**	**100.0**	**100.0**	
How long have you been using computer?	Never	**63**	**42.0**	**42.3**	**42.3**
	1-3 Years	**50**	**33.3**	**33.6**	**75.8**
	4-6 Years	**23**	**15.3**	**15.4**	**91.3**
	More than 6 years	**13**	**8.7**	**8.7**	**100.0**
	Total	**149**	**99.3**	**100.0**	
	Missing	**1**	**.7**		
What is your level of experience with computer literacy?	Nothing	**30**	**20.0**	**20.1**	**20.1**
	Beginner	**78**	**52.0**	**52.3**	**72.5**
	Intermediate	**40**	**26.7**	**26.8**	**99.3**
	Expert	**1**	**.7**	**.7**	**100.0**
	Total	**149**	**99.3**	**100.0**	
	Missing	**1**	**.7**		
Do you have access to the Internet?	No	**103**	**68.7**	**69.1**	**69.1**
	Yes	**46**	**30.6**	**30.9**	**100**
	Total	**149**	**99.3**	**100.0**	
	Missing	**1**	**.7**		
How long have you been using the Internet	0 years	**33**	**22.0**	**22.1**	**22.1**
	1-3 years	**65**	**43.3**	**43.6**	**65.8**
	4-6 years	**26**	**17.3**	**17.4**	**83.2**
	More than 6 years	**25**	**16.7**	**16.8**	**100.0**
	Total	**149**	**99.3**	**100.0**	
	Missing	**1**	**.7**		
How much time do you often spend on the Internet in a day?	Less than 1 hour	**42**	**28.0**	**28.4**	**28.4**
	1 – 4 hours	**75**	**50.0**	**50.7**	**79.1**
	More than 4 hours	**31**	**20.7**	**20.9**	**100**
	Total	**148**	**98.7**	**100.0**	
	Missing	**2**	**1.3**		
What is your level of experience with on-line courses?	No experience	**90**	**60.0**	**60.0**	**60.0**
	Beginner	**46**	**30.7**	**30.7**	**90.7**
	Intermediate	**10**	**6.7**	**6.7**	**97.3**
	Well experienced	**4**	**2.7**	**2.7**	**100**
	Missing	**0**	**0**		

This table therefore gives preliminary data about students' internet experience and online learning. Data in table 5.1 show that most of the students completed the questions, with only a few missing values. A quick glance at the table clearly shows that the most frequent choices are "some experience" in terms of internet and Moodle experience. Most students indicated that they did not have computers at home (N = 90; 60%), and had never used a computer, and therefore their computer literacy was at an elementary level. A majority of the students (N =103; 68.67%) further indicated that they did not have access to the internet in their homes. Many of these students (N=90; 60%), also indicated that they did not have experience in terms of online learning.

5.2.3 Pre-Intervention SDLRS Statistical analysis

The SDLRS comprises 18 items on a 5-point Likert-scale that measures self-directed learning readiness on three dimensions. These are; (i) Self-management (6 items), (ii) Desire for mathematics learning (6 items), and (iv) Self-control (6 items). The respondents were to choose 1 if they strongly disagreed that the item measures their characteristic, 2 if they disagreed, 3 if they neither agreed nor disagreed, 4 if they agreed, and 5 if they strongly agreed that the items measure their characteristic.

The analysis and discussion of data were done based on the rating criteria as suggested and recommended by Klunklin *et al.*, (2010) as well as El Seesya, Sofar and Al-Battawi (2017) [see tables 5.2 and 5.3].

Table 5.2: Percentage SDL rating (El Seesya, Sofar and Al-Battawi, 2017)

Percentage Score	**Rating**
< 50%	Low SDL
≥50% <75%	Moderate SDL
≥ 75%	High SDL

Table 5.3: Mean SDL rating (Klunklin *et al*., 2010)

Mean score	**Rating**
Average score of from 1.00 - 1.50	extremely low degree of SDL
Average score of from 1.51 - 2.50	low degree of SDL
Average score of from 2.51 - 3.50	medium degree of SDL
Average score of from 3.51 - 4.50	high degree of SDL
Average score of from 4.51 - 5.00	extremely high degree of SDL

The total number of responses to the Pre-Intervention SDLRS questionnaire is displayed in figure 5.3:

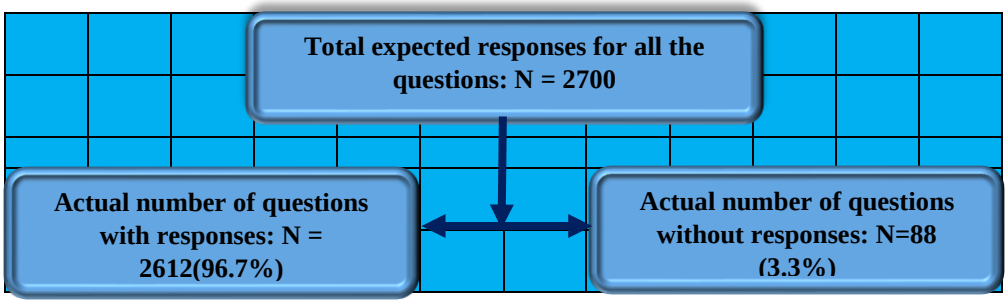


Figure 5.3: Flowchart of Pre-Intervention SDLRS questionnaire response rates

Figure 5.3 displays a high percentage of students who responded. The total expected responses for all the questions in the questionnaire was 2700. The valid number of responses was 2 612 (96.74%), with 88 missing values (3.26%).

Summary of the findings emerging from the Pre-Intervention SDLRS Statistical Data [subscales of the questionnaire per question].

Table 5.4 displays the Pre-Intervention SDLRS visual statistical data of the respondents. This includes the number valid (N valid), number missing (N missing), mean, mode, standard deviation, and variance.

Table 5.4: Pre-Intervention SDLRS Statistical Data

Factor	Code	Sub factor	N valid	N missing	Mean	Mode	Std. deviation	Variance
Self-Management	SM1	I am self-disciplined	**146**	**4**	**3.03**	**3.00**	**.85**	**.72**
	SM2	I have good management skills	**144**	**6**	**2.88**	**3.00**	**.79**	**.62**
	SM3	I set time frames for my study	**146**	**4**	**2.82**	**3.00**	**.86**	**.75**
	SM4	I can be trusted to pursue my own learning	**144**	**6**	**2.86**	**3.00**	**.84**	**.71**
	SM5	I prefer to plan my own learning	**145**	**5**	**2.93**	**3.00**	**.86**	**.73**
	SM6	I am confident in my ability to search out information	**141**	**9**	**2.90**	**3.00**	**.89**	**.71**
Desire for Mathematics learning	DML1	I have a passion for Mathematics	**147**	**3**	**2.66**	**3.00**	**1.00**	**1.00**
	DML2	I have a passion to learn mathematics concepts	**146**	**4**	**2.74**	**3.00**	**.88**	**.77**
	DML3	I critically evaluate new ideas	**144**	**6**	**2.74**	**3.00**	**.93**	**.86**
	DML4	I like to evaluate what I do	**145**	**5**	**2.89**	**3.00**	**.78**	**.60**
	DML5	I am open to new ideas	**145**	**5**	**2.96**	**3.00**	**.77**	**.59**
	DML6	When presented with a problem I cannot resolve I always ask for assistance	**144**	**6**	**2.72**	**3.00**	**.95**	**.90**
Self-Control	SC1	I prefer to set my own learning goals	**147**	**3**	**3.01**	**3.00**	**.85**	**.73**
	SC2	I like to make decisions for myself	**146**	**4**	**2.95**	**3.00**	**.83**	**.69**
	SC3	I always set high personal standards	**146**	**4**	**2.90**	**3.00**	**.99**	**.98**
	SC4	I evaluate my own performance	**145**	**5**	**2.88**	**3.00**	**1.02**	**1.05**
	SC5	I can find out information for my self	**146**	**4**	**2.89**	**3.00**	**.85**	**.72**
	SC6	I prefer to set my own criteria on which to evaluate my performance	**145**	**5**	**2.81**	**3.00**	**.91**	**.83**

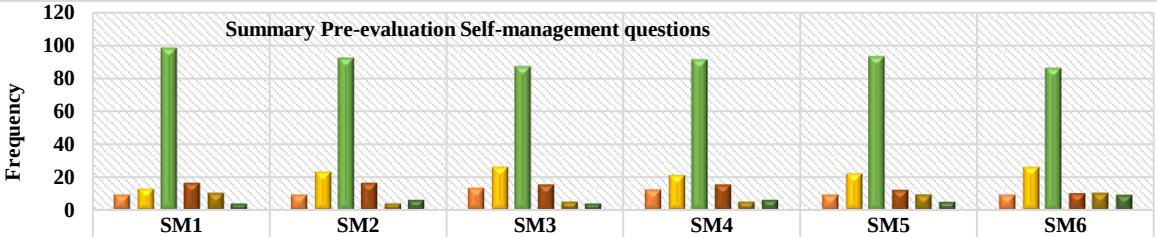
`

The overall data analysis as displayed in table 5.4 shows that the total mean for all the questions is 2.87, the mode is 3, the standard deviation is 0.88, and the variance is 0.78. In terms of the mean

analysis criteria as provided by Klunklin *et al*., (2010), the data show that students have inadequate self-management skills, inadequate desire for mathematics learning and display inadequate self-concept skills which are needed for self-directed learning. Students' modal choice (3.0) shows that most of them are undecided in terms of their self-management skills, desire for mathematics learning and self-concept.

5.2.3.1 Findings emerging from sub-Factor 1: Self-Management

Students were asked to rank their opinions on self-management skills in this item. The competence of students to carry out their planned learning goals and the efficient administration of the appropriate learning resources that are available to them are both addressed by the subscale of self-management (Klunklin *et al*., 2010). Students were asked to evaluate their self-management style with respect to self-discipline, management skills, time frames setting, the pursuit of own learning, planning and confidence in their ability to search out information. The summary of their responses to all the questions in this sub factor are displayed in the bar graph (see figure 5.4).



	SM1	SM2	SM3	SM4	SM5	SM6
SD	9	9	13	12	9	9
D	13	23	26	21	22	26
NAND	98	92	87	91	93	86
A	16	16	15	15	12	10
SA	10	4	5	5	9	10
MISSING	4	6	4	6	5	9

Figure 5.4. The summary of students' responses to the "Self-Management" sub factor

The bar graph (figure 5.4) displays the average responses for the whole self-management sub factor. Upon analysing the data, it was revealed that on average, 10 students (6.67%) strongly disagreed that they possessed good self-management skills. 22(14.67%) disagreed, 91(60.67%) were undecided, 14 (9.33%) agreed and 7(4.67%) strongly agreed. The average missing value is 6 (4%). According to the criteria analysis provided by El Seesya, *et al*. (2017) scores below 50 % show low SDL readiness, scores from 50% to less than 75% show moderate SDL readiness while scores from 75% and above show high SDL readiness.

In the self-management sub factor only 21 students (14%) have good management skills. Most students therefore do not have the necessary self-management skills needed for self-directed

learning. The mean score of the participants for self-management was 2.90, the standard deviation was 0.85 and the variance was 0.71 and the mode was 3. The mean and the mode are closer to the undecided score. In terms of the mean analysis criteria as provided by Klunklin *et al*. (2010), the data show that students have a medium degree of self-management skills which are inadequate for SDL. Students' modal choice (3.0) shows that most of them are undecided in terms of their self-management skills. The mean data analysis also shows a relative standard deviation (RSD) of 2.9 ± 29.2%. The 29.2% is a low relative standard deviation which confirms that the participants' choices are closer to the mean, which is itself closer to the undecided score. Accordingly, the students who completed the questionnaire have low management skills needed for self-directed learning.

Self-management factor analysis: students' responses per question

Question SM1: I am self-disciplined.

The bar chart (figure 5.5) provides a visual depiction of "I am self-disciplined" distribution question.

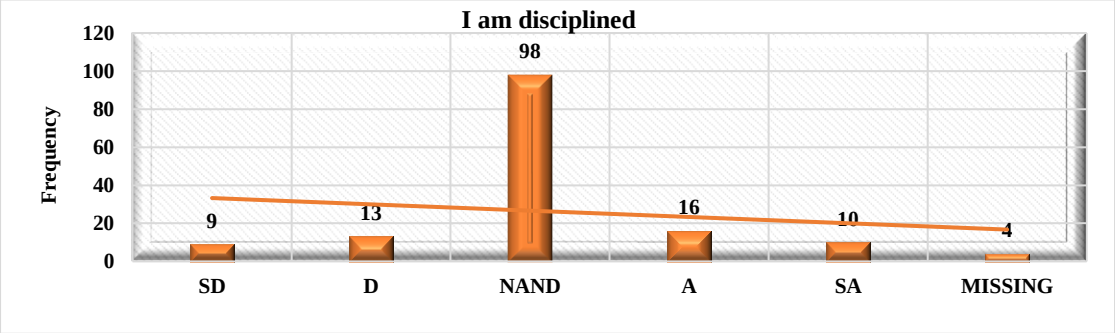


Figure 5.5: The summary of students' responses to the "I am self-disciplined" sub factor

This question assessed the students' capacity for self-control, as well as their willingness to exert effort or behave in a certain way without outside direction. The data shows that the most frequent choice is "NAND" (N= 98; 65.33%) option. El Seesya, *et al*. (2017), provided a percentage criterion for analysing SDL (see table 2). The analysis in terms of this criteria shows that **most** students (N =120; 80%) have a low level of self-discipline skills needed for self-directed learning. Research indicates that "low level of self-discipline leads to different problems in students' educational, social, and personal life" (de Ridder *et al*., 2012, p. 96).

Hofmann *et al*., (2014) on the other hand, argues that:

> strong confidence and high level of self-discipline facilitates success, better achievements and reaching the goals which, in their turn, improve the mood and makes students happier and gladder.

Question SM2: I have good management skills

The bar chart (figure 5.6) provides a visual depiction of the "I have good management skills" distribution question.

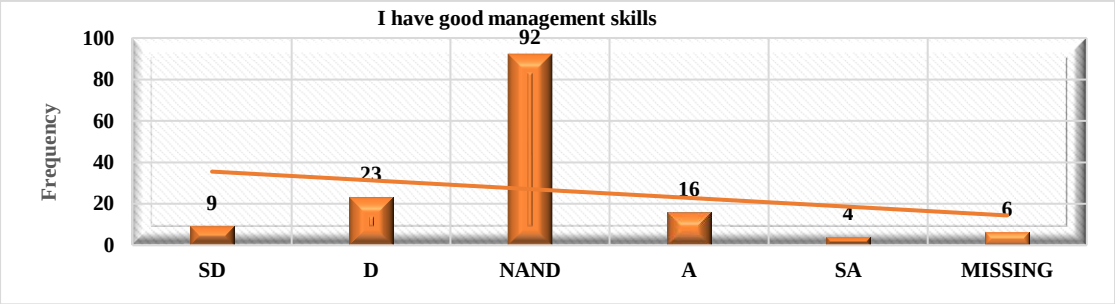


Figure 5.6: The summary of students' responses to the "I have good management skills" sub factor

The ability of the students to manage their own learning during the course of self-directed learning was evaluated by this question. The data analysis of the "I have good management skills" sub factor shows that the most frequent choice is "NAND" (N = 92; 61.33%) option, and the least was "SA" (N = 4; 2.67 %) option. The interpretation of the results in terms of the criteria as provided by El Seesya, *et al*. (2017), shows that only few students have good management skills needed for self-directed learning. The data distribution on the graph (see figure 5.6), clearly shows that more data fall toward the lower side of the scale and there are very few higher scores. Data distribution is therefore positively skewed. From this distribution, it can thus be deduced that most respondents (N= 124; 82.67%) have a low level of management skills needed for self-directed learning.

Question SM3: I set time frames for my study

The bar chart (figure 5.7) provides a visual depiction of the "I set time frames for my study" distribution question.

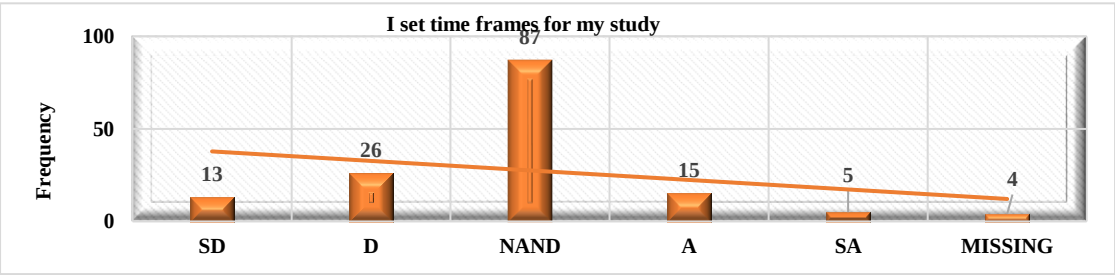


Figure 5.7: The summary of students' responses to the "I set time frames for my study" sub factor

Question SM3: I set time frames for my study assessed the students' abilities on setting strict time frames so as to engage adequately. The data analysis clearly shows that the most frequent choice on the Likert scale is "NAND" (N = 87; 58%), followed by "Disagree" (N = 26, 17.33%). In terms of the analysis criteria provided by El Seesya, *et al*. (2017), this analysis shows that most students (N =126; 84%) do not consider setting time frames for their studies as important. From the trendline on the graph (figure 5.7), we can clearly see that the data is right skewed. Most scores fall towards the lower side of the scale and there are very few higher scores. From this distribution, it can thus be deduced that the majority of participants do not like setting time frames for their studies.

Question SM4: I can be trusted to pursue my own learning

The bar chart (figure 5.8) provides a visual depiction of the "I can be trusted to pursue my own learning" distribution question.

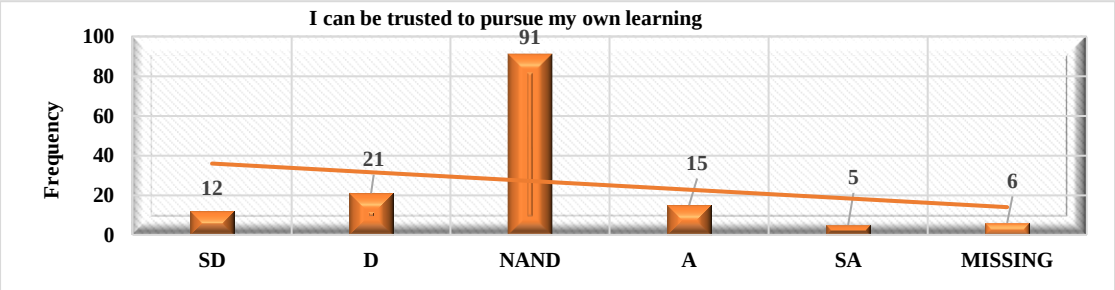


Figure 5.8: The summary of students' responses to the "I can be trusted to pursue my own learning" sub factor

This question tested the students' confidence in pursuing their own learning. This includes taking the initiative when learning. Students' responses to this question show an inability to pursue own learning. A glance at this graph clearly shows that the most frequent choice on the Likert scale is "NAND" (N = 91; 60.67%), followed by "Disagree" (N = 21, 14%). The least choice was "Strongly Agree" (N = 5; 3.33%). The graph (figure 5.8) clearly displays a positively skewed data. The distribution, therefore, tells that most of the respondents (N = 124; 82.67) do not prefer pursuing their own learning. The skill to pursue one's own learning is one of the prerequisites for self-directed learning.

Question SM5: I prefer to plan my own learning

The bar chart (figure 5.9) provides a visual depiction of "I prefer to plan my own learning" distribution question.

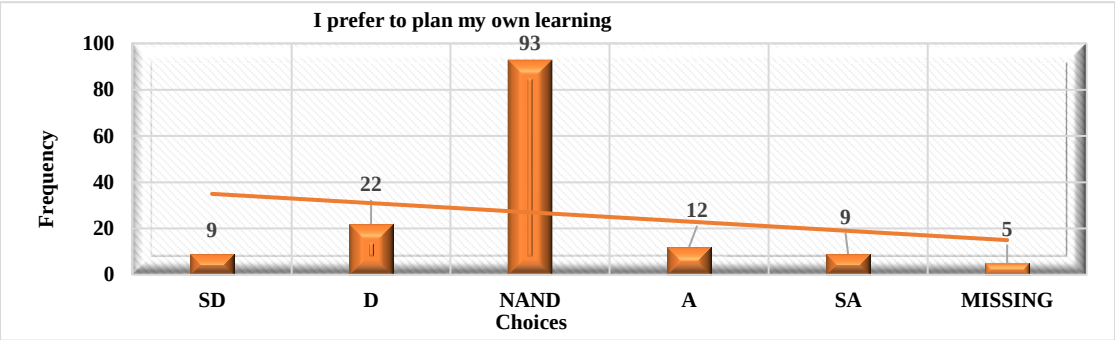


Figure 5.9: The summary of students' responses to the "I prefer to plan my own learning" sub factor

This question tested the students' ability in taking the initiative to set learning goals within a guided and supportive learning environment. Data analysis on this question clearly shows that the most frequent choice on the Likert scale is "NAND" (N = 93; 62%), followed by "Disagree" (N = 22, 14.7%). The least choices were "Strongly Disagree" (N= 9; 6%) and "Strongly Agree" (N = 9; 6%). A preview of the data distribution on the graph (see figure 5.9) reveals that most scores fall towards the lower side of the scale and there are very few higher scores. Data distribution is, therefore, positively skewed. From this distribution, it can thus be deduced that the majority of participants do not prefer to plan their own learning as required of university students for self-directed learning.

Question SM6: I am confident in my ability to search out information

The bar chart (figure 5.10) provides a visual depiction of the "I am confident in my ability to search out information" distribution question.

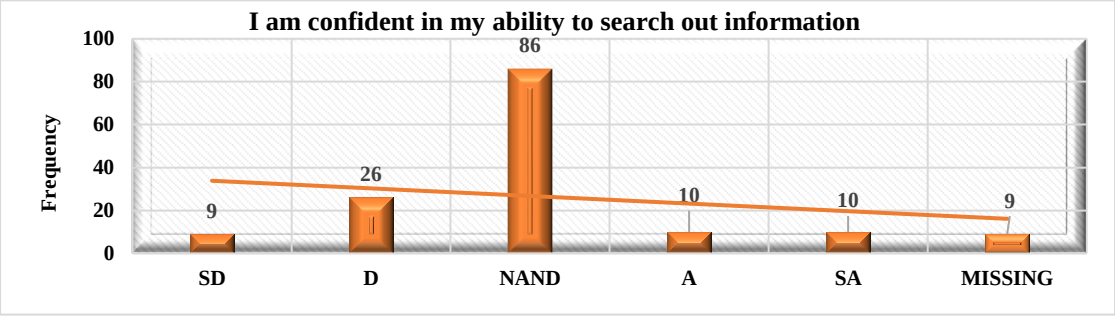
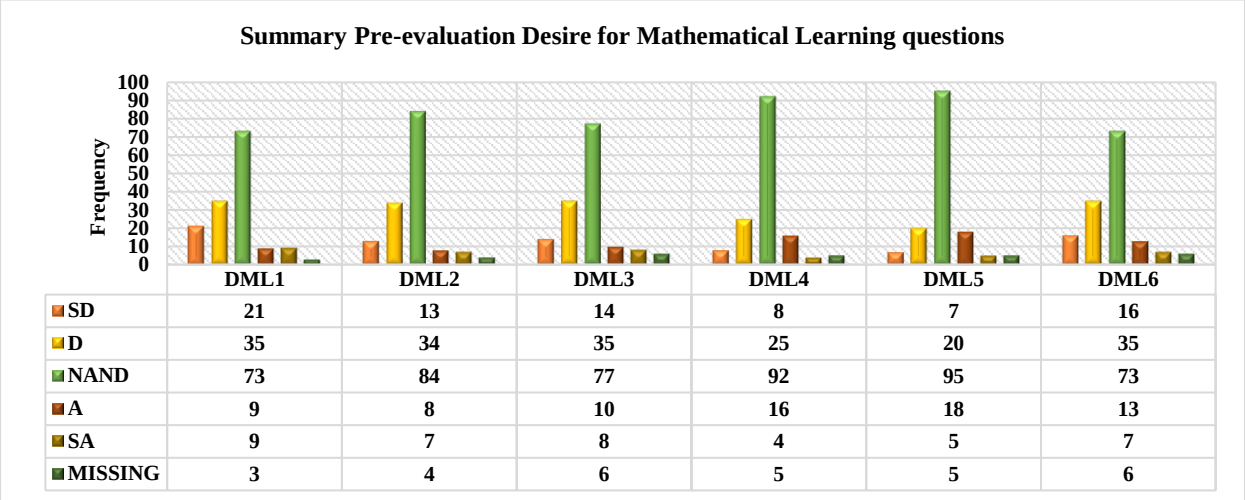


Figure 5.10: The summary of students' responses to the "I am confident in my ability to search out information" sub factor

This question tested the students' confidence in their ability to search for information on their own. Upon analysing the data, it was revealed that most students (N=121; 80.67). are not confident to search information on their own. The trend line on the graph (see figure 5.10) shows that data are positively skewed with most scores falling toward the lower side of the scale and there are very few higher scores. From this distribution, it can thus be deduced that most participants are not confident in their ability to search out information. Self-directed learning requires students to be confident in their own ability to search for information.

5.2.3.2 Findings emerging from Sub Factor 2: Desire for Mathematical Learning

In this item, students were asked to give their rank of opinions towards their desire for mathematical learning. The desire to learn has to with the students' motivation levels and their ability to realistically seek out new information to address their learning needs in a beneficial and enjoyable way (Fisher & King, 2010). In this sub factor, students were asked, on a 5-point Likert-scale, to indicate their desire for mathematical learning, with regard to passion for mathematics, evaluating new ideas and asking for assistance when faced with complex problems. The summary of their responses to all the questions in this sub factor is displayed in the bar graph as displayed in figure 5.11.



	DML1	DML2	DML3	DML4	DML5	DML6
SD	21	13	14	8	7	16
D	35	34	35	25	20	35
NAND	73	84	77	92	95	73
A	9	8	10	16	18	13
SA	9	7	8	4	5	7
MISSING	3	4	6	5	5	6

Figure 5.11: The summary of students' responses to the "Desire for Mathematical Learning" sub factor

The bar graph (figure 5.11) displays the average responses for the whole "Desire for Mathematical Learning" sub factor. Upon analysing the data, one notes that on average, 13 students (8.67%) strongly disagreed that they have passion for mathematical learning. 31(20.67%) disagreed, 81(54%) were undecided, 12 (8%) agreed and 7(4.67%) strongly agreed. The average missing

values for "Desire for Mathematical Learning" sub factor are 6 (4%). The data, therefore, show that only 19 (12.67%) respondents have passion and desire for mathematics learning. According to El Seesya, *et al*. (2017) scores below 50 % show low SDL readiness, scores from 50% to less than 75% show moderate SDL readiness while scores from 75% show high SDL readiness. In this questionnaire, only 19 students (12.67%) showed that they had a desire for mathematical learning. The students therefore have low percentage passion for needed for mathematics learning.

The mean score of the participants for "Desire for Mathematical Learning" sub factor was 2.78, the standard deviation was 0.89 and the variance was 0.79 and the modal score was 3. The mean and the mode are closer to the undecided score. In terms of the mean analysis criteria as provided by Klunklin *et al*., (2010), the data show that students have a medium desire for mathematics learning which is inadequate for SDL. Students' modal choice (3) shows that most of them are undecided in terms of their desire for mathematics learning. The mean data analysis also shows a relative standard deviation (RSD) of 2.8 ± 32.4%. The 32.4% confirms a low relative standard deviation which also affirms that the participants' choices are closer to the mean, which is itself closer to the undecided score. Accordingly, the students who completed the questionnaire have low desire for mathematical learning. The desire for mathematics factor analysis per students' responses per question are presented below:

Question DML1: I have a passion for mathematics

The bar chart (figure 5.12) provides a visual depiction of "I have a passion for mathematics" distribution question.

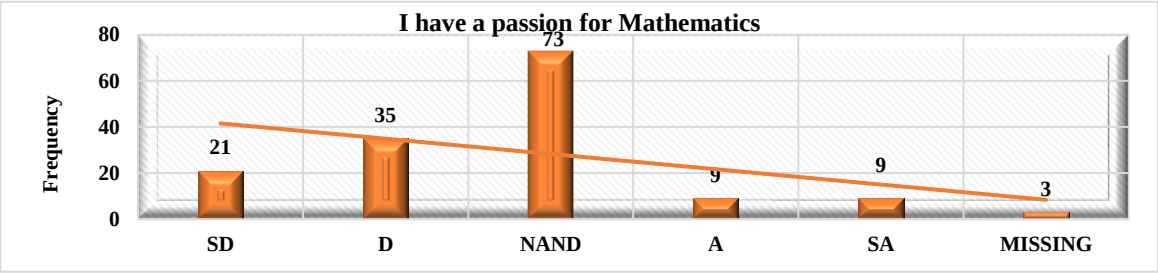


Figure 5.12: The summary of students' responses to the "I have a passion for mathematics" sub factor

This question tested the students' passion towards mathematics. The data analysis of the "I have a passion for mathematics" sub factor shows that the most frequent choice is "NAND" (N = 73; 48.67%), followed by the disagree choice (N = 35; 23.33%). In terms of the data analysis criteria as provided by El Seesya, *et al*. (2017), this is an indication of a lack of passion for mathematics. The trend line on the graph (see figure 5.12) shows positively skewed data. The inference that can

be made from this distribution is that the majority of the participants (N =129; 86%) do not have a passion for mathematics, which is one of the prerequisites needed for self-directed learning (Ruiz-Alfonso & León, 2017).

Question DML2: I have a passion to learn mathematics concepts

The bar chart (figure 5.13) provides a visual depiction of "I have a passion to learn mathematics concepts" distribution question.

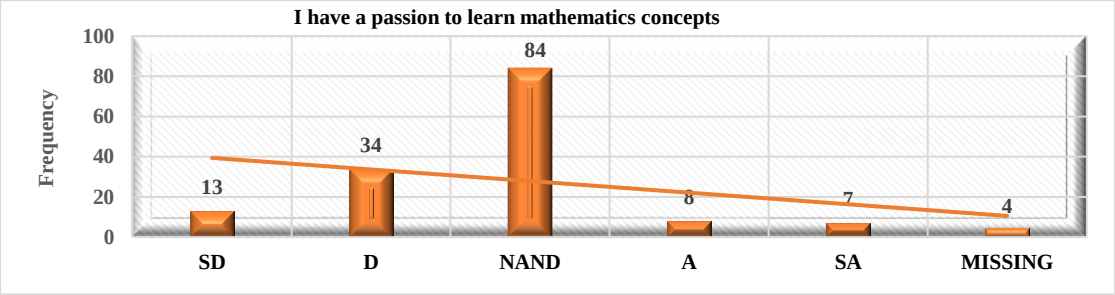


Figure 5.13: The summary of students' responses to the "I have a passion to learn mathematics concepts" sub factor

This question tested the students' passion to learn mathematics concepts**.** The data analysis of "I have a passion to learn mathematics concepts" sub factor shows that the most frequent choice on the Likert scale is "NAND" (N = 84; 56%), followed by "Disagree" (N = 34, 22.67%). The least choice was "SA" (N = 7; 4.67%). In terms of the analysis criteria as provided by El Seesya, *et al*. (2017), this is an indication that most students lack passion to learn mathematics concepts. The data distribution on the graph (see figure 5.13), clearly shows that more data fall towards the lower side of the scale and there are very few higher scores. Data distribution is, therefore, positively skewed. From this distribution, it can thus be deduced that most of the participants (N = 131; 87.33) do not have a passion to learn mathematics concepts.

Question DML3: I critically evaluate new ideas

The bar chart (figure 5.14) provides a visual depiction of "I critically evaluate new ideas" distribution question.

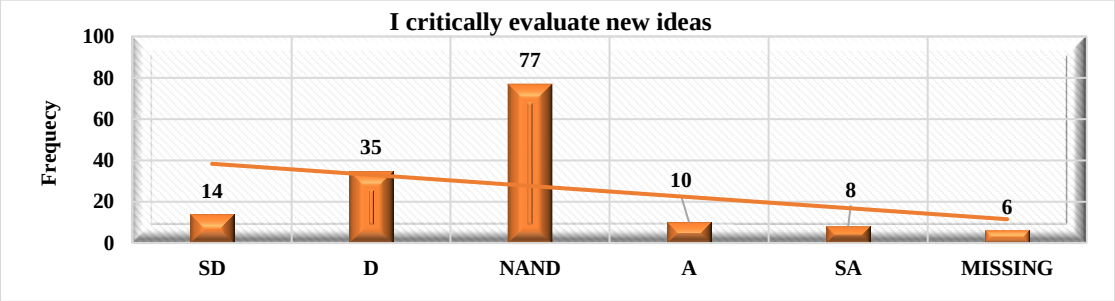


Figure 5.14: The summary of students' responses to the "I critically evaluate new ideas" sub factor

This question tested the students' views in critically evaluating new ideas. The most frequent choice is "NAND" (N = 77; 51.33%), followed by "Disagree" (N = 35, 23.33%). The least choice was "Strongly Agree" (N = 8; 5.33%). Data analysis in terms of the criteria provided by El Seesya, *et al.* (2017) shows that **most** students (N =126; 84%), do not prefer to critically evaluate new ideas. The data distribution on the graph (see figure 5.14), displays a skewed distribution to the right, which is said to be positive. This is because most scores fall towards the lower side of the scale and there are very few higher scores. From this distribution, it can, thus, be deduced that the majority of the participants do not have the competency of critically evaluating new ideas. University students are expected to have a creative and innovative thinking mentality to critically evaluate new ideas.

Question DML4: I like to evaluate what I do

The bar chart (figure 5.15) provides a visual depiction of "I like to evaluate what I do" distribution question.

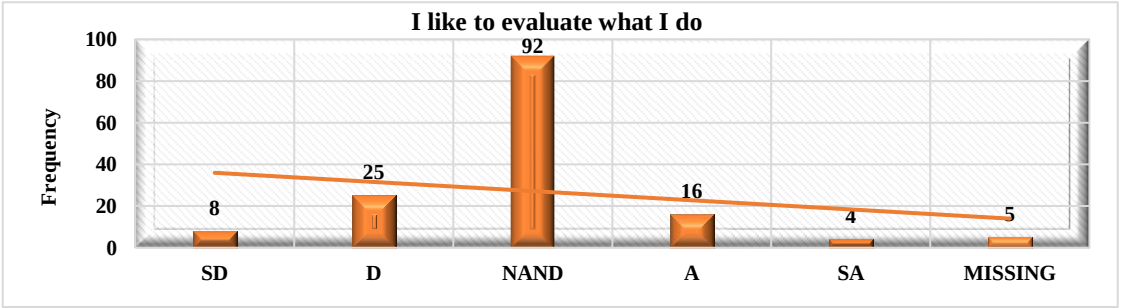


Figure 5.15: The summary of students' responses to the "I like to evaluate what I do" sub factor

This question tested the students' views in evaluating what they do when learning. Evaluation is an important component of SDL. Students' responses to this question show an inability to evaluate what they do. A glance at this graph clearly shows that the most frequent choice on the Likert scale is "NAND" (N = 92; 61.33%), followed by "Agree" (N = 16, 10.67%). The least choice was "Strongly Agree" (N = 5; 3.33%). The bar graph data distribution (see figure 5.15) clearly shows distribution with a few very high scores. Data distribution is, therefore, positively skewed. The inference that can be made from this distribution is that most of the participants (N = 125; 83.33) do not enjoy evaluating what they learn.

Question DML5: I am open to new ideas

The bar chart (figure 5.16) provides a visual depiction of "I am open to new ideas" distribution question.

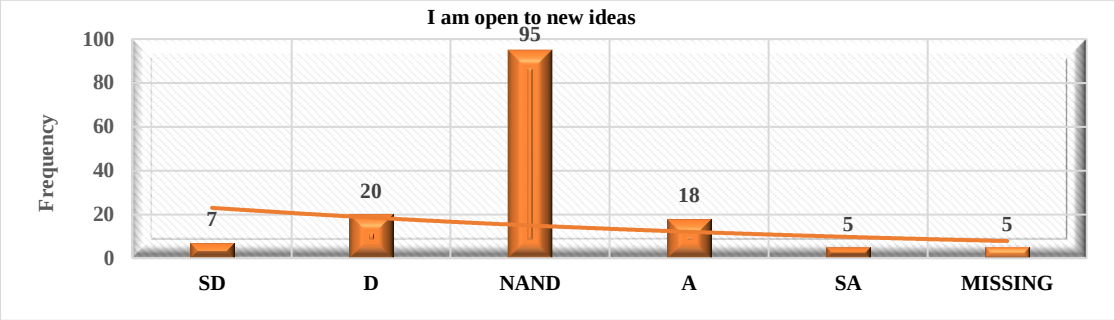


Figure 5.16: The summary of students' responses to the "I am open to new ideas" sub factor

This question tested the students' views to accept and be influenced by new ideas. Communication is crucial in online SDL. A glance at this graph clearly shows that the most frequent choice on the Likert scale is "NAND" (N = 95; 63.33%), followed by "Agree" (N = 18, 12%). The least choice was "Strongly Agree" (N = 5; 3.33%). The graph bar graph (see figure 5.16) thus displays a positively skewed data distribution. From this distribution, it can thus be deduced that the majority of the participants (N = 122; 81.33), were either undecided, disagreed or strongly disagreed with the idea of being open to new ideas. Research indicates that being open to new ideas and divergent perspectives has potential to increase empathy, tolerance for others' views, and can lead to the accuracy and depth of one's understanding (Kalyani & Rajasekaran, 2018).

Question DML6: When presented with a problem I cannot resolve, I always ask for assistance.

The bar chart (figure 5.17) provides a visual depiction of "When presented with a problem I cannot resolve I always ask for assistance" distribution question.

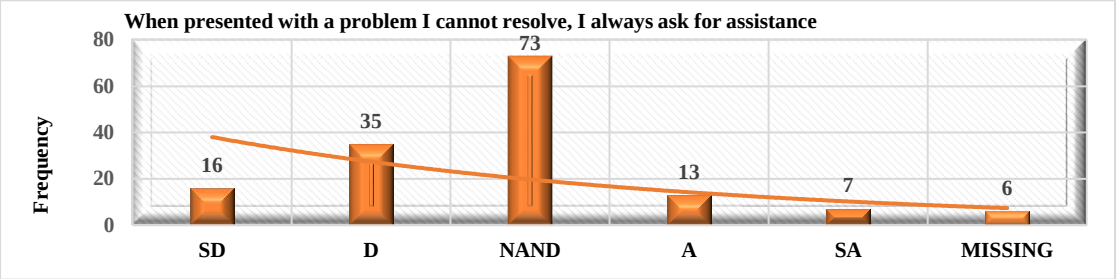
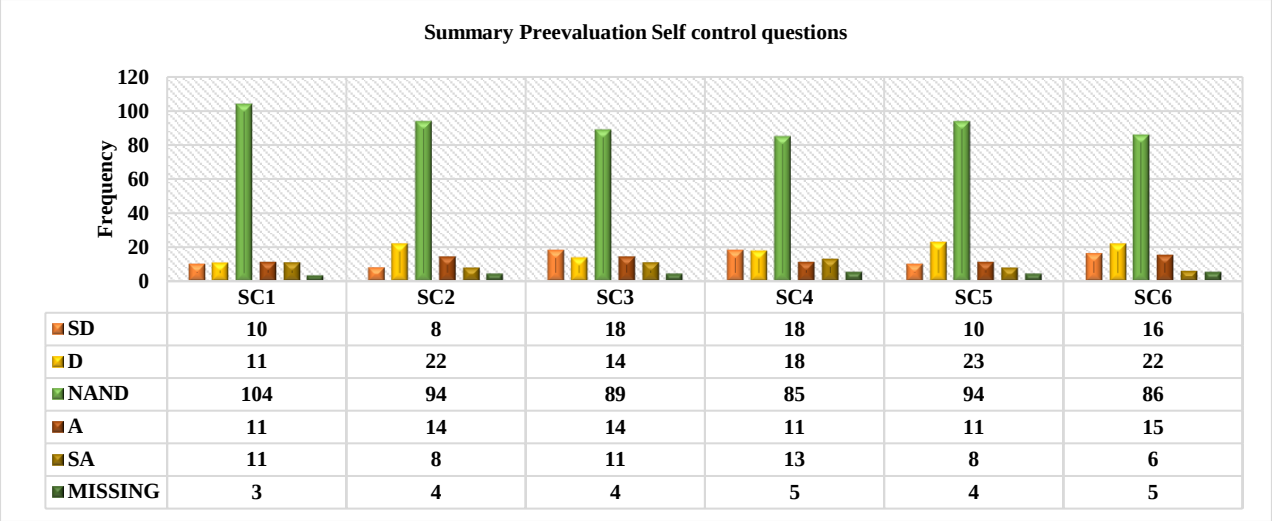


Figure 5.17: The summary of students' responses to the "When presented with a problem I cannot resolve I always ask for assistance" sub factor

This question tested the students' views in seeking assistance for mathematics tasks they cannot solve. Collaboration is one of the skills promoted by SDL. A glance at this graph clearly shows that the most frequent choice on the Likert scale is NAND (N = 73; 48.67%), followed by "Agree" (N = 13, 8.67%). The least choice was "Strongly Agree" (N = 7; 4.67%). The trendline on the graph (see figure 5.17) displays positively skewed data. This is because most of the data are on the lower scores. The inference that can be made from this distribution is that most of the participants (N = 124; 82.67), are not comfortable with asking for assistance when faced with problems they cannot solve themselves.

5.2.3.3 Findings emerging from Sub Factor 3: Self-Control

Self-control is an SDL attribute that empowers the learner to be in charge of their own education. Williams *et al.*, (2013, p. 108) claim that "the ability of students to self-monitor and assess their attainment of predetermined learning goals and outcomes depends on their level of self-control". In this sub factor, students were asked, on a 5-point Likert-scale, to indicate their preference to set their own learning goals, their decision-making, setting of personal standards, their own performance evaluation, finding information and setting of own criteria. In this item, students were asked to give their rank of opinions towards self-control skills. The summary of their responses to all the questions in this sub factor are displayed in the bar chart (see figure 5.18).



	SC1	SC2	SC3	SC4	SC5	SC6
SD	10	8	18	18	10	16
D	11	22	14	18	23	22
NAND	104	94	89	85	94	86
A	11	14	14	11	11	15
SA	11	8	11	13	8	6
MISSING	3	4	4	5	4	5

Figure 5.18: The summary of students' responses to the "Self-Control" sub factor

The bar graph (figure 5.18) displays the average responses for the whole "self-control" sub factor. Upon analysing the data, it is revealed that on average, 9 students (6%) strongly agreed that that they have good self-control skills needed for self-directed learning. 12 students (8%) agreed, 14 students (9.3%) strongly disagreed, 18 students (12%) disagreed, and 92 students (61.33%) were undecided. The average missing values for the "self-control" sub factor are 5 (3.33%). The percentage of those who agreed is far below the moderate level as recommended by El Seesya, *et al.* (2017). According to them (El Seesya, *et al*., 2017) scores below 50 % show low SDL readiness, scores from 50% to less than 75% show moderate SDL readiness while scores from 75% show high SDL readiness.

The mean score of the participants for "self-control" sub factor was 2.91, the standard deviation was 0.91 and the variance was 0.83 and the modal score was 3. The mean and the mode are closer to the undecided score. In terms of the mean analysis criteria as provided by Klunklin *et al.* (2010), the data show that students have inadequate self-concept skills which are prerequisites for self-directed learning. Students' modal choice (3) shows that most of them are undecided in terms of their self-control. The mean data analysis also shows a relative standard deviation (RSD) of 2.9 ± 31.03%. The 31.03% affirms a low relative standard deviation which means the participants' choices are closer to the mean, which is itself closer to the undecided score. Accordingly, the students who completed the questionnaire have inadequate self-control skills needed for self-directed learning. The self-control factor analyses per students' responses per question is depicted hereunder:

Question SC1: I prefer to set my own learning goals

The bar chart (figure 5.19) provides a visual depiction of "I prefer to set my own learning goals" distribution question.

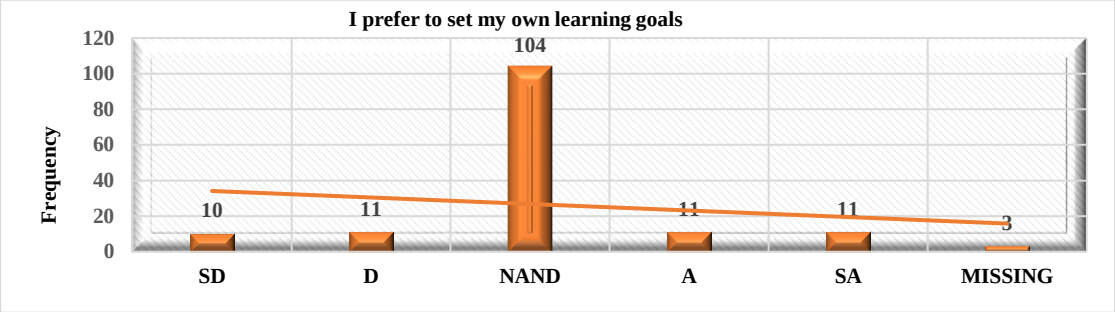


Figure 5.19: The summary of students' responses to the "I prefer to set my own learning goals" sub factor

This question tested the students' abilities to set their own learning goals. SDL needs students to set their own learning goals. Data analysis of this sub factor clearly shows that the most frequent choice on the Likert scale is "NAND" (N = 104; 69.33%). The least choice was "Strongly Disagree" (N = 10; 6.67%). This means that they do not prefer to set their own learning goals. University students whose teaching and learning is based on self-directed learning should be able to set their own learning goals.

Question SC2: I like to make decisions for myself.

The bar chart (figure 5.20) provides a visual depiction of "I like to make decisions for myself" distribution question.

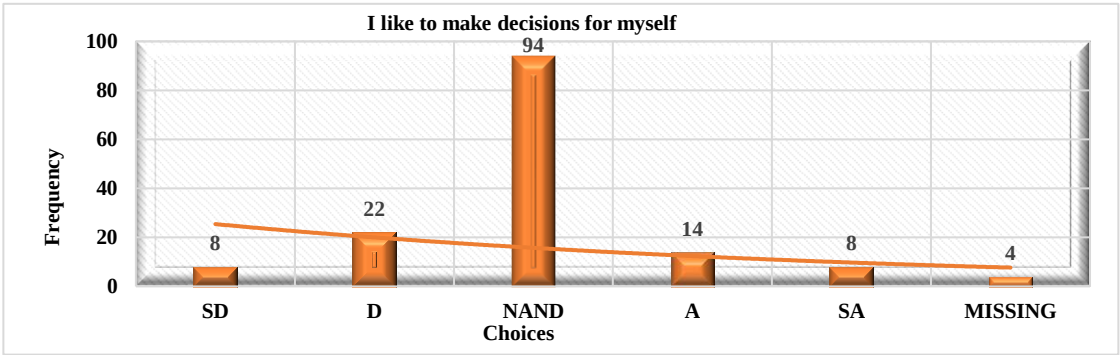


Figure 5.20: The summary of students' responses to the "I like to make decisions for myself" sub factor

This question tested the students' ability to make their own decisions. Self-directed students are expected to make independent decisions. Upon analysing the data, it was revealed that the most

frequent choice on the Likert scale is "NAND" (N = 94; 62.67%), followed by "Disagree" (N = 22, 14.67%). The least choice was "Strongly Agree" (N = 8; 5.33%). The data distribution on the graph (see figure 5.20), clearly shows that most of the participants (N = 124; 82.67), do not have the ability to make their own decisions. This is because there are many choices on the lower scores. This is an unfortunate situation because university students are expected to be engaged in SDL. There is, therefore, a tremendous need for students to have the ability and competence to make their own decisions.

Question SC3: I always set high personal standards

The bar chart (figure 5.21) provides a visual depiction of "I always set high personal standards" distribution question.

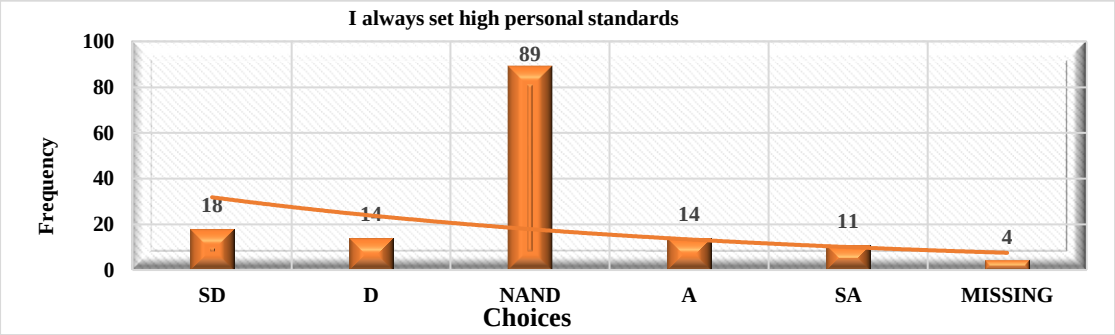


Figure 5.21: The summary of students' responses to the "I always set high personal standards" sub factor

This question tested the students' ability to set their own high personal standards. In SDL, students are expected to be self-motivated to set their own high standards. Data analysis in this question reveals the most frequent choice on the Likert scale is "NAND" (N = 89; 59.33%), followed by "Strongly Disagree" (N = 18, 12%). The least choice was "Strongly Agree" (N = 11; 7.33%). The bar graph data distribution (see figure 5.21) clearly shows a positively skewed data. From this distribution, it can, thus, be deduced that most of the participants (N=121) do not always set high personal standards. University students are expected to be active and creative thinkers, with the ability and competence to develop their own personal standards.

Question SC4: I evaluate my own performance

The bar chart (figure 5.22) provides a visual depiction of "I evaluate my own performance" distribution question.

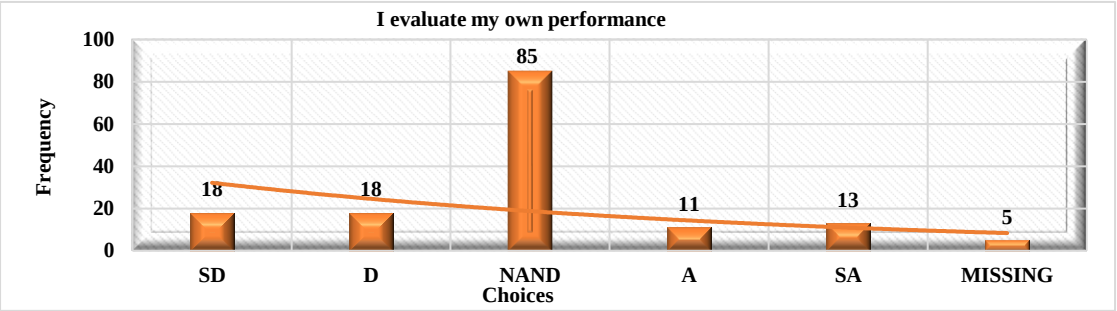


Figure 5.22: The summary of students' responses to the "I evaluate my own performance" sub factor

This question tested the students' abilities to evaluate their own performance. In SDL, students are expected to evaluate their own performance. Similarly, as is the case in the previous question, data analysis reveals that the most selected option was "NAND" (N = 85; 56.67%). The data distribution on the graph (see figure 5.22), clearly shows that more data fall toward the lower side of the scale and there are very few higher scores. Data distribution is, therefore, positively skewed. This distribution tells that many of the students who participated in this study do not always evaluate their own performance. To become lifelong learners, university students need self-evaluation and self-reflection skills. This will assist them in monitoring their own progress when learning.

Question SC5: I can find out information for myself

The bar chart (figure 5.23) provides a visual depiction of "I can find out information for myself" distribution question.

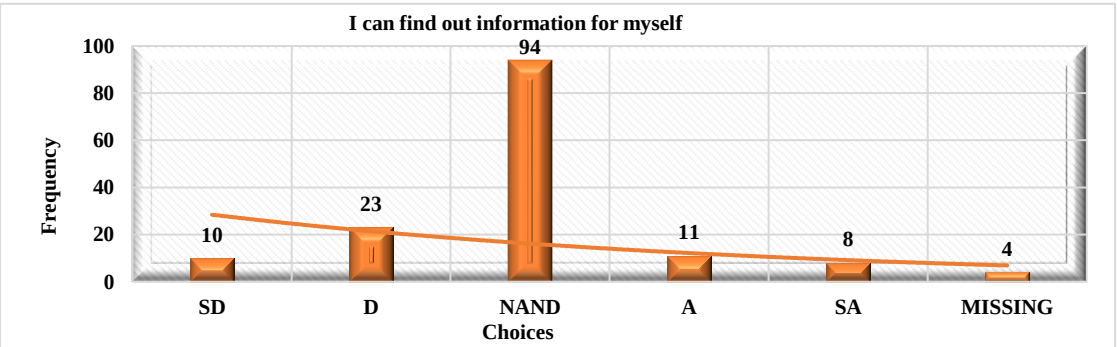


Figure 5.23: The summary of students' responses to the "I can find out information for myself" sub factor

This question tested the students' ability to find out information for themselves. Information seeking is one of the SDL skills. Data analysis clearly shows that the most frequent choice on the Likert scale is "NAND" (N = 94; 62.67%), followed by "Disagree" (N = 23, 15.33%). The least choice was "Strongly Agree" (N = 8; 5.33%). From the trendline on the graph (figure 5.23) we can clearly see that the data is right skewed. Most scores fall towards the lower side of the scale and there are very few higher scores. From this distribution, it can, thus, be deduced that most of the participants (N= 127; 84.67%), expressed difficulty in finding information on their own. University students are expected to have their own self-study skills, which will assist them to be able to go beyond simply learning what their lecturers teach them.

Question SC6: I prefer to set my own criteria on which to evaluate my performance

The bar chart (figure 5.24) provides a visual depiction of "I prefer to set my own criteria on which to evaluate my performance" distribution question.

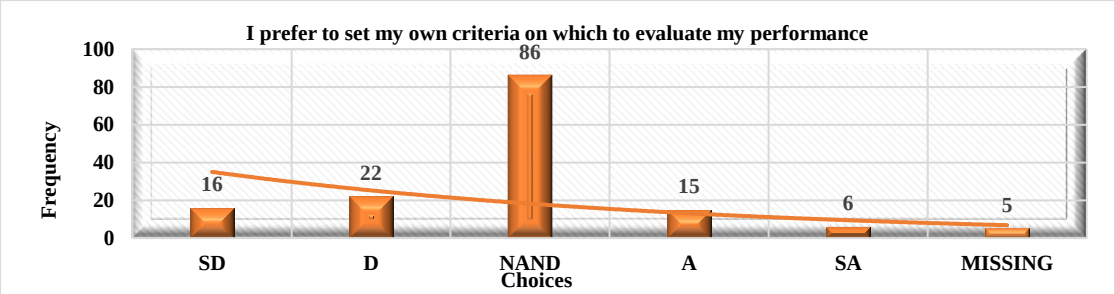


Figure 5.24: The summary of students' responses to the "I prefer to set my own criteria on which to evaluate my performance" sub factor

This question tested the students' ability to set their own criteria on which to evaluate their performance. Upon analysing the data in this question, it was revealed that the most frequent choice on the Likert scale is "NAND" (N = 86; 57.33%), followed by "Strongly Disagree" (N = 16, 10.67%). The least choice was "Strongly Agree" (N = 6; 4%). The data distribution on the graph (see figure 5.24), displays a skewed distribution to the right, which is said to be positive. This is because most scores fall towards the lower side of the scale and there are very few higher scores. From this distribution, it can thus be deduced that most of the participants (N =124; 82.67), do not have the competency to set their own criteria on which to evaluate their performance. Setting their own criteria will go a long way in assisting students to identify their skill gaps, and areas where their knowledge is weak.

This section presented quantitative data from the pre-evaluation questionnaires. Therefore, it gives preliminary data about students' Moodle experience and self-directed learning readiness. The preliminary data indicate that most students have neither Moodle nor internet experience. Data

analysis also shows that most students' self-directed readiness is low. Full discussion of the data analysis will be done in chapter 6. The next section presents quantitative data analysis for the post evaluation questionnaires.

5.3 Post Intervention SDLRS-SPQ Statistical analysis

In the post evaluation questionnaire (see table 5.5), students were required to report on their self-directed learning status in an academic context, using the Self-Directed Learning Readiness-Self Perception Questionnaire (SDLRS-SPQ). The SDLRS-SPQ comprises 38 items on a 5-point Likert-scale that measures self-directed learning readiness perception on seven dimensions, namely; (i) Self-management (6 items), (ii) Desire for mathematics learning (6 items), (iii) Self-control (6 items), (iv) Moodle Perceived Usefulness (6 items), (v) Moodle Self-Efficacy (6items), (vi) Moodle Perceived Ease of Use (4 items) and (vii) Moodle Attitude (4 items). The respondents were to choose 1 if they strongly disagreed that the item measured their characteristic, 2 if they disagreed that the item measured their characteristic, 3 if they neither agreed nor disagreed (unsure) that the item measured their characteristic of themselves, 4 if they agreed that the item measured their characteristic, and 5 if they strongly agreed that the item measured their characteristic.

The total number of responses to the Post Intervention SDLRS-SPQ questionnaire is displayed in figure 5.25:

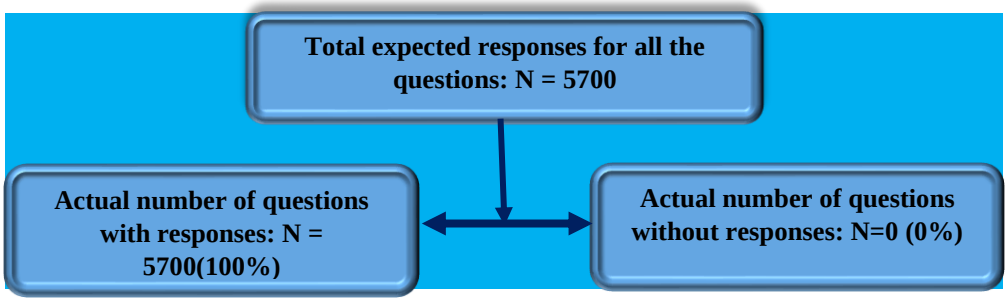


Figure 5.25: Flowchart of the Post Intervention SDLRS-SPQ questionnaire response rates

The valid number of responses in this questionnaire was 5 700. Figure 5.3 display a 100% of students' responses. As was the case, in the pre-evaluation questionnaire, the analysis, interpretation and discussion of data were done based on the rating criteria as suggested and recommended by Klunklin *et al.*, (2010) as well as El Seesya, *et al*. (2017).

Tabular representation of the Post Intervention SDLRS-SPQ Statistical Data.

Table 5.5 displays the SDLRS-SPQ visual statistical data of the respondents. This includes the number valid (N valid), number missing (N missing), mean, mode, standard deviation and variance.

Table 5.5: Post Intervention SDLRS-SPQ Statistical Data

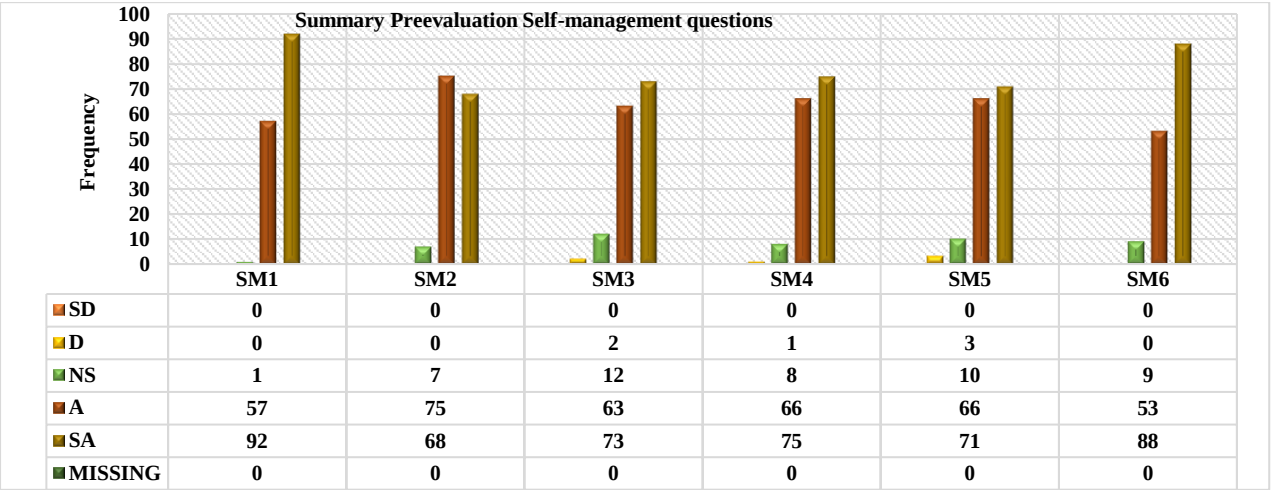
Factor	Sub factor	N valid	N missing	Mean	Mode	Std. deviation	Variance
Self-Management	I am self-disciplined	150	0	4.61	5.00	.50	.25
	I have good management skills	150	0	4.41	4.00	.58	.34
	I set time frames for my study	150	0	4.38	5.00	.69	.480
	I can be trusted to pursue my own learning	150	0	4.43	5.00	.63	.40
	I prefer to plan my own learning	150	0	4.367	5.00	.70	.49
	I am confident in my ability to search out information	150	0	4.53	5.00	.61	.37
Desire for Mathematics learning	I have a passion for Mathematics	150	0	4.39	5.00	.77	.59
	I have a passion to learn mathematics concepts	150	0	4.37	4.00	.65	.42
	I critically evaluate new ideas	150	0	4.26	4.00	.71	.50
	I like to evaluate what I do	150	0	4.33	4.00	.70	.49
	I am open to new ideas	150	0	4.47	5.00	.67	.45
	When presented with a problem I cannot resolve, I always ask for assistance	150	0	4.26	5.00	.99	.99
Self-Control	I prefer to set my own learning goals	150	0	4.49	5.00	.57	.32
	I like to make decisions for myself	150	0	4.51	5.00	.58	.33
	I always set high personal standards	150	0	4.40	5.00	.64	.40
	I evaluate my own performance	150	0	4.42	4.00	.58	.34
	I can find out information for myself	150	0	4.41	4.00	.63	.39
	I prefer to set my own criteria on which to evaluate my performance	150	0	4.39	5.00	.73	.53
Moodle Perceived Usefulness	Moodle helps me to learn more efficiently	150	0	4.49	5.00	.63	.40
	Moodle improves my academic performance	150	0	4.45	5.00	.62	.38
	Moodle makes my learning more effective	150	0	4.45	5.00	.63	.40
	Moodle makes it easier to learn at university	150	0	4.53	5.00	.60	.36
	Moodle gives me control over my learning	150	0	4.41	5.00	.72	.51
	Overall, Moodle is advantageous for my learning	150	0	4.49	5.00	.60	.36
Moodle Self-Efficacy	I can access the contents of Moodle	150	0	4.58	5.00	.57	.33
	I can freely navigate the contents of Moodle	150	0	4.44	5.00	.59	.34
	I can use Moodle without needing to be told how it functions	150	0	4.45	5.00	.69	.49
	I can solve problems that arise on Moodle	150	0	4.15	5.00	.89	.78
	I can use Moodle if there are user manuals available	150	0	4.41	5.00	.70	.49
	Overall, I am able to use Moodle	150	0	4.56	5.00	.60	.36
Moodle Perceived Ease of Use	Learning to use Moodle is easy for me	150	0	4.43	5.00	.71	.50
	It is easy to get materials from Moodle	150	0	4.43	5.00	.73	.53
	The process of using Moodle is clear and understandable	150	0	4.42	5.00	.74	.55
	Overall, I believe that Moodle is easy to use	150	0	4.51	5.00	.80	.64
Moodle Attitude	Learning using Moodle is fun	150	0	4.40	5.00	.84	.71
	Using Moodle is a good idea	150	0	4.45	5.00	.75	.56
	Using Moodle is an attractive way to learn	150	0	4.43	5.00	.79	.62
	Overall, I like using Moodle	150	0	4.57	5.00	.71	.50

The overall data analysis shows that the total mean for all the questions is 4.43, the mode is 5, the standard deviation is 0.68, and the variance is 0.47. In terms of the mean analysis interpretation criteria as provided by Klunklin *et al*., (2010), the data show that students have high self-management skills, high desire for mathematics learning and display high self-concept skills in their learning. Students also display a highly positive attitude towards Moodle teaching and

learning. This is shown by their modal choices of Moodle perceived usefulness, Moodle self-efficacy, and Moodle perceived ease of use.

5.3.1 Findings emerging from Sub Factor 1: Self-Management

The summary of the students' responses to all the questions in the Self-Management sub factor are displayed in bar graph, figure 5.26.



	SM1	SM2	SM3	SM4	SM5	SM6
SD	0	0	0	0	0	0
D	0	0	2	1	3	0
NS	1	7	12	8	10	9
A	57	75	63	66	66	53
SA	92	68	73	75	71	88
MISSING	0	0	0	0	0	0

Figure 5.26: The summary of students' responses to the "Self-Management" sub factor

Upon analysing the data, it was revealed that on average, 141 students (94%) either strongly agreed or agreed that they had good self-management skills, 7 students (4.67%) were not sure, while only 2 students (1.33%) disagreed. According to the analysis and interpretation criteria provided by El Seesya, *et al*. (2017) scores from 75% and above show high SDL readiness. In the self-management sub factor, it can, thus, be inferred that students now have good management skills. Most students (N = 141; 94%), have the necessary self-management skills needed for self-directed learning.

The mean score of the participants for self-management was 4.45, the standard deviation was 0.62 and the variance was 0.39 and the mode was 5. This mean is closer to the highest score on the Likert scale. The mean data analysis shows a relative standard deviation (RSD) of 4.5 ± 13.9%. The 13.9% shows a low relative standard deviation which tells that the participants' choices are closer to the mean. In terms of the mean analysis criteria as provided by Klunklin *et al*. (2010), the data also show that students have high self-management skills. Students' modal choice also confirms that most participants' self-management skills have improved. Accordingly, the students now have high self-management skills which will surely contribute to their online self-directed

learning. High self-management skills are an indication that students have positive attitude towards SDL (Singh & Paudel, 2020).

Self-management factor analysis: students' responses per question

Question SM1: I am self-disciplined

The bar chart (figure 5.27) provides a visual depiction of the "I am self-disciplined" distribution question.

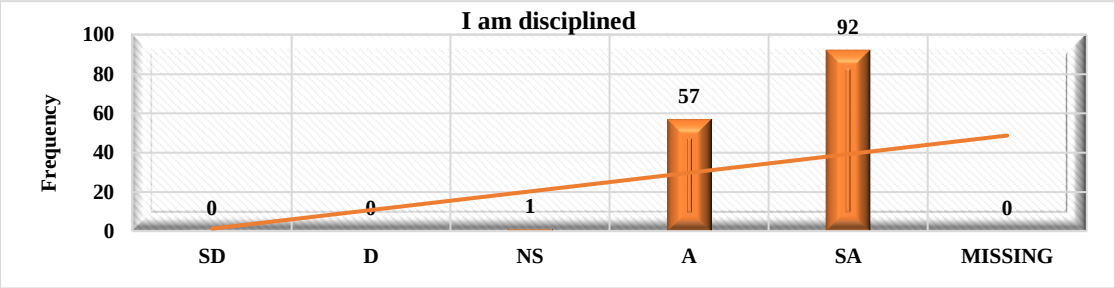


Figure 5.27: The summary of students' responses of the "I am self-disciplined" sub factor

The data shows that the most frequent choice is "SA" option (N = 92; 61.33%), followed by the "A" option. El Seesya, Sofar and Al-Battawi (2017), provided a percentage criterion for analysing SDL (see table 5.2). The analysis interpretation in terms of this criteria shows that most students (N = 149; 99.33), have a high level of good self-discipline skills needed for self-directed learning. These results show that students now have strong confidence and a high level of self-discipline. This will help facilitate success, better achievements and reaching their goals. They are now able to take control of their academic lives, set goals, and take concrete steps to achieve them. High self-discipline is an indication of self-confidence and self-esteem. This can lead to high academic performance and high success rate.

Question SM2: I have good management skills

The bar chart (figure 5.28) provides a visual depiction of the "I have good management skills" distribution question.

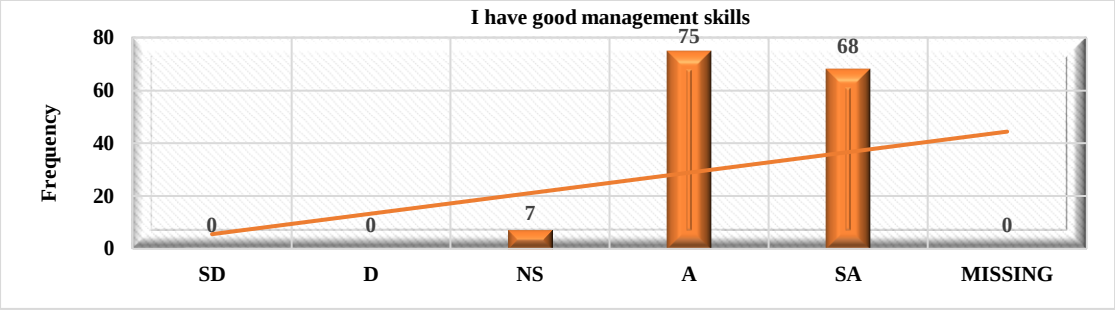


Figure 5.28: The summary of students' responses to the "I have good management skills" sub factor

The data analysis of "I have good management skills" sub factor shows that the most frequent choice is the "A" option (N = 75; 50%), followed by the "SA" (N = 68; 45.33%) option. This means that the majority of the respondents (n = 143; 95.3%) now agree that they have good management skills. The interpretation of the results in terms of the criteria as provided by El Seesya, *et al*. (2017), shows that the majority of students now have good management skills needed for SDL. The data distribution on the graph (see figure 5.6), clearly shows that more data fall toward the higher side of the scale and there are very few lower scores. Data distribution is therefore negatively skewed. From this distribution, it can thus be deduced that most respondents (N=143), have a high level of good management skills needed for self-directed learning.

Question SM3: I set time frames for my study

The bar chart (figure 5.29) provides a visual depiction of "I set time frames for my study" distribution question.

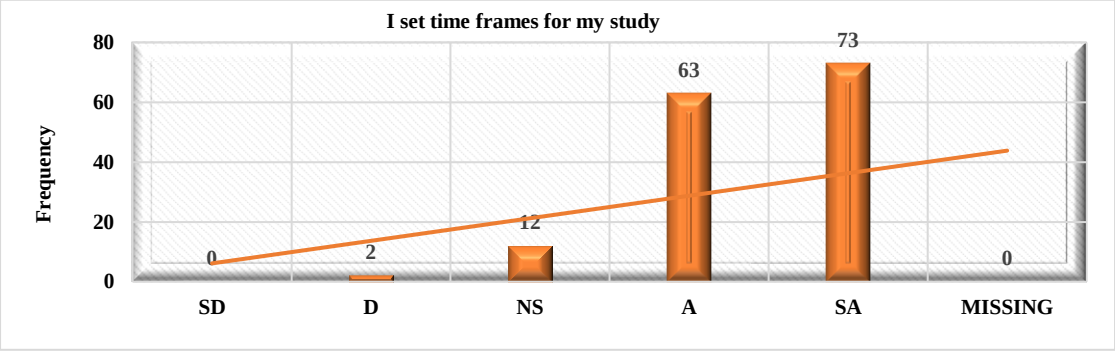


Figure 5.29: The summary of students' responses to the "I set time frames for my study" sub factor

The data analysis clearly shows that the most frequent choice on the Likert scale is "SA" (N = 136; 48.67%) option, followed by "A" (N = 63, 42%) option. This analysis shows that the majority of the respondents (N = 136; 90.67%) are now able to set time frames for their studies. From the trendline on the graph (figure 5.29), we can clearly see that the data is left skewed. Most scores fall towards the higher side of the scale and there are very few lower scores. The inference that can be made from this distribution is that the majority of participants like setting time frames for their studies. This tells that the majority of the participants now understand the importance of setting time frames for their studies. This will have a positive impact on their self-directed learning.

Question SM4: I can be trusted to pursue my own learning

The bar chart (figure 5.30) provides a visual depiction of "I can be trusted to pursue my own learning" distribution question.

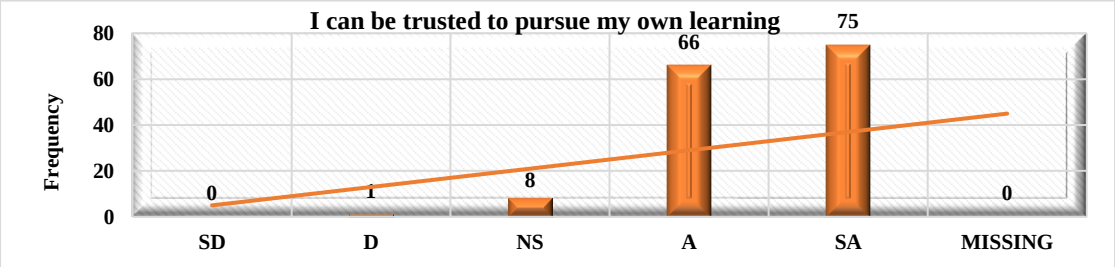


Figure 5.30: The summary of students' responses to the "I can be trusted to pursue my own learning" sub factor

A glance at this graph clearly shows that the most frequent choice on the Likert scale is "SA" (N = 75; 50%) option, followed by "A" (N = 66, 44%) option. The graph (figure 5.30) clearly displays a negatively skewed data distribution. This distribution, therefore, tells that most of the respondents now prefer pursuing their own learning. The skill to pursue one's own learning is one of the prerequisites for self-directed learning.

Question SM5: I prefer to plan my own learning.

The bar chart, (figure 5.31) provides a visual depiction of "I prefer to plan my own learning" distribution question.

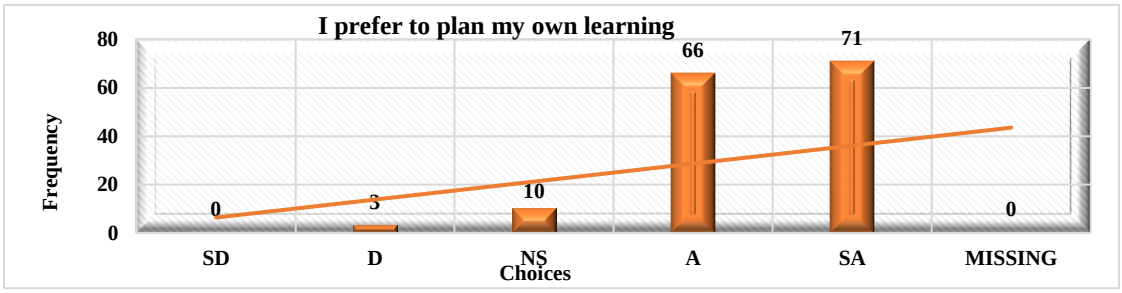


Figure 5.31: The summary of students' responses to the "I prefer to plan my own learning" sub factor

Data analysis on this question clearly shows that the most frequent choice on the Likert scale is "SA" (N = 71; 47.33%) option, followed by "A" (N = 66, 44%) option. The data distribution on the graph (see figure 5.31), shows that most scores fall towards the higher side of the scale and there are very few lower scores. Therefore, this data distribution is negatively skewed. From this distribution, it can thus be deduced that the majority of the participants (N = 137; 91.33%), prefer to plan their own learning (self-directed learning) as required of university students.

Question SM6: I am confident in my ability to search out information

The bar chart (figure 5.32) provides a visual depiction of "I am confident in my ability to search out information" distribution question.

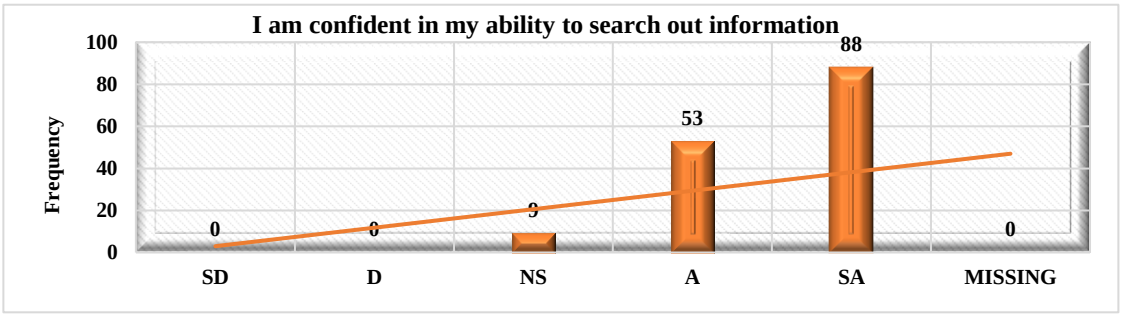
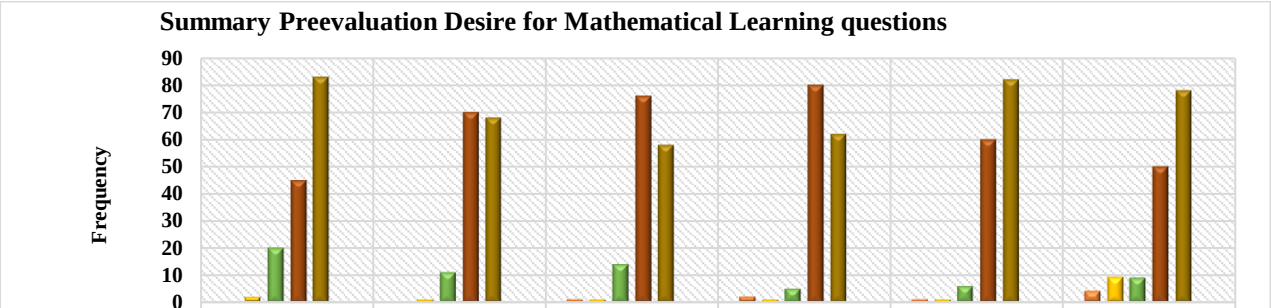


Figure 5.32: The summary of students' responses to the "I am confident in my ability to search out information" sub factor

Upon analysing the data, it was revealed that most students are now confident to search information on their own. The highest number of selection was the "SA" (N = 88; 58.67%) option, followed by the "A" (N = 53; 35.33%). The trend line on the graph (see figure 5.32) shows that data distribution is negatively skewed with most scores falling toward the higher side of the scale with very few lower scores. From this distribution, it can thus be deduced that most of the participants (N = 141; 94%), are now confident in their ability to search out information. Self-directed learning requires students to be confident in their own ability to search for information.

5.3.2 Findings emerging from Sub Factor 2: Desire for Mathematical Learning

The bar graph, (figure 5.33) provides a summary of students' responses to "Desire for Mathematical Learning" questions.



	DML1	DML2	DML3	DML4	DML5	DML6
SD	0	0	1	2	1	4
D	2	1	1	1	1	9
NS	20	11	14	5	6	9
A	45	70	76	80	60	50
SA	83	68	58	62	82	78
MISSING	0	0	0	0	0	0

Figure 5.33: The summary of students' responses to the "Desire for Mathematical Learning" sub factor

The bar graph (figure 5.33) displays the average responses to "Desire for Mathematical Learning" sub factor. The data analysis reveals that on average, 72 students (48%) strongly agreed while 63 students (42%) agreed that they have a desire for mathematical learning. only 1 student (0.7%) strongly disagreed, 3 students (2%) disagreed, while 11 students (7.3%) were undecided. The data clearly show that the majority of the students (N = 135; 90%) have passion and desire for mathematics learning. In terms of the analysis criteria as provided by El Seesya, *et al*. (2017), it can thus be inferred that these students have a high degree of passion needed for mathematics self-directed learning.

The mean score of the participants for "Desire for Mathematical Learning" sub factor is 4.35, the standard deviation 0.75 and the variance 0.58 and the modal score 4. The mean data analysis also shows a relative standard deviation (RSD) of 4.4 ± 17.3%. The low percentage of the RSD (17.3%) shows that the participants' choices are closer to the mean. In terms of the mean analysis criteria as provided by Klunklin *et al*., (2010), the data show that students have a high desire for mathematics learning. Students' modal choice also confirms that the participants' desire for mathematical learning has improved. Accordingly, the students who completed the questionnaire now perceive Moodle as a good LMS. High desire for mathematical learning is an indication that students have positive attitude towards SDL (Ruiz-Alfonso & León, 2017). Hereunder follow desire for mathematics factor analysis, students' responses per question:

Question DML1: I have a passion for mathematics

The bar chart (figure 5.34) provides a visual depiction of the "I have a passion for mathematics" distribution question.

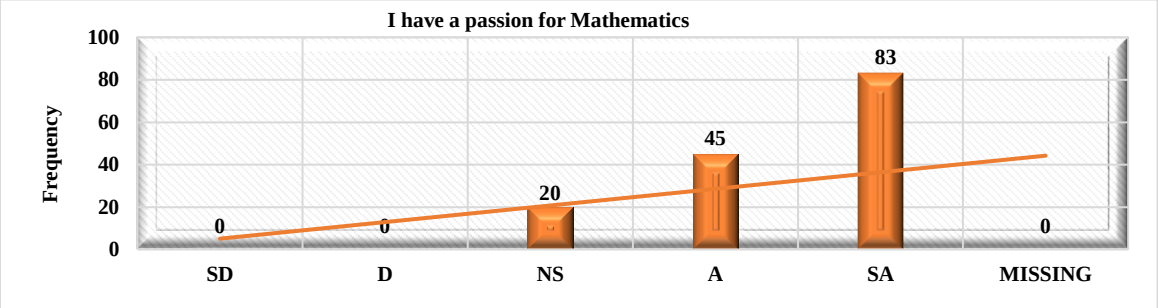


Figure 5.34: The summary of students' responses to the "I have a passion for mathematics" sub factor

The data analysis of "I have a passion for mathematics" sub factor shows that the most frequent choice is "SA" (N = 83; 55.33%) option, followed by the "A" (N = 45; 30%) option. This means that 128 respondents (85.33%) now have a high passion for learning mathematics. The trend line on the graph (see figure 5.34) shows positively skewed data distribution. The inference that can be made from this distribution is that the majority of the participants (N = 128, 85.33%), now have a passion for mathematics, which is one of the prerequisites needed for self-directed learning (Ruiz-Alfonso & León, 2017).

Question DML2: I have a passion to learn mathematics concepts

The bar chart (figure 5.35) provides a visual depiction of "I have a passion to learn mathematics concepts" distribution question.

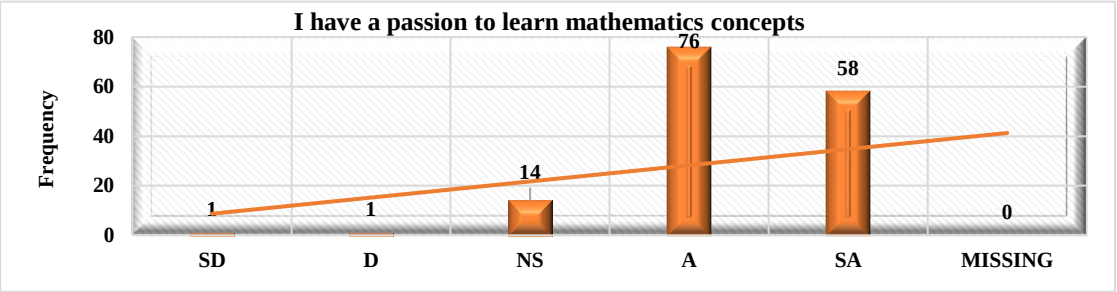


Figure 5.35: The summary of students' responses to the "I have a passion to learn mathematics concepts" sub factor

The data analysis of the "I have a passion to learn mathematics concepts" sub factor shows that the most frequent choice on the Likert scale is "A" (76 = 84; 50.67%) option, followed by the "SA" (N = 58, 38.67%) option. In terms of the data analysis interpretation criteria as provided by El Seesya, *et al*. (2017), this is an indication that most students have a high passion to learn

mathematics concepts. The data distribution on the graph (see figure 5.35), clearly shows that more data fall towards the higher side of the scale and there are very few lower scores. The data distribution is therefore negatively skewed. From this distribution, it can thus be deduced that most of the participants (N = 134; 89.33%), have developed a passion to learn mathematics concepts after intervention. According to Ruiz-Alfonso and León (2017), this passion may lead to mathematics self-directed learning.

Question DML3: I critically evaluate new ideas

The bar chart (figure 5.36) provides a visual depiction of "I critically evaluate new ideas" distribution question.

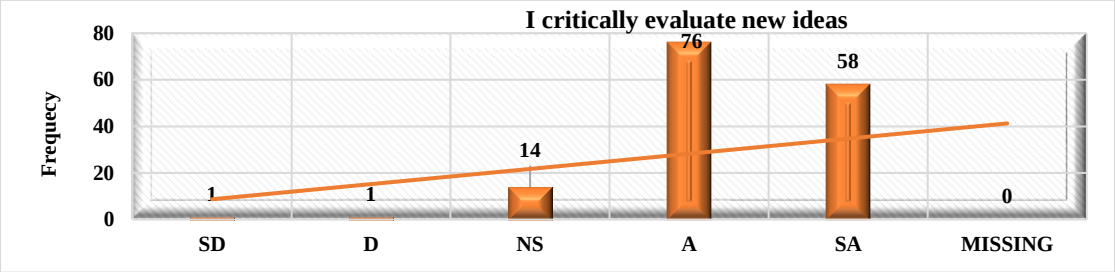


Figure 5.36: The summary of students' responses to the "I critically evaluate new ideas" sub factor

The most frequent choice is the "A" (76 = 84; 50.67%) option, followed by the "SA" (N = 58, 38.67%) option. Data analysis show that most students (N = 134; 89.33%), prefer to critically evaluate new ideas. The data on the graph (see figure 5.36), display a left skewed distribution, which is said to be negative. This is because most scores fall towards the higher side of the scale and there are very few lower scores. From this distribution, it can thus be deduced that the majority of the participants now have the competency of critically evaluating new ideas. University students are expected to have a creative and innovative thinking mentality to critically evaluate new ideas.

Question DML4: I like to evaluate what I do

The bar chart (figure 5.37) provides a visual depiction of "I like to evaluate what I do" distribution question.

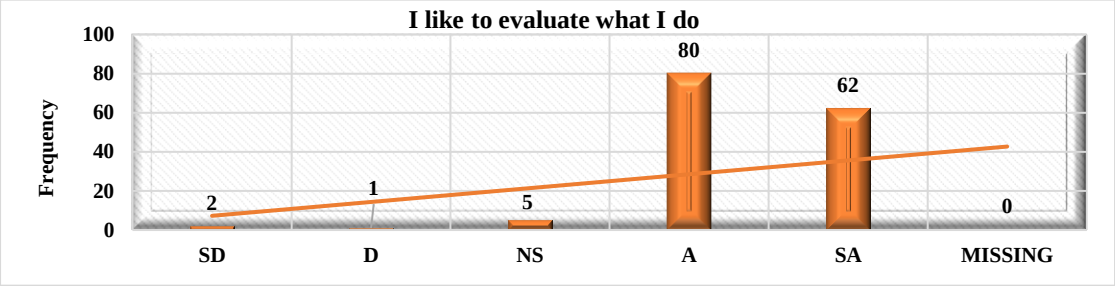


Figure 5.37: The summary of students' responses to the "I like to evaluate what I do" sub factor

Students' responses to this question show a high degree of the ability to evaluate what they do. A glance at this graph clearly shows that the most frequent choice on the Likert scale is "A" (N = 80; 53.33%) option, followed by the "SA" (N = 62, 41.33%) option. The bar graph data (see figure 5.37), clearly shows distribution with many high scores. Data distribution is therefore negatively skewed. The inference that can be made from this distribution is that most of the participants (N = 142; 94.67%), seem to enjoy evaluating what they learn.

Question DML5: I am open to new ideas

The bar chart (figure 5.38) provides a visual depiction of "I am open to new ideas" distribution question.

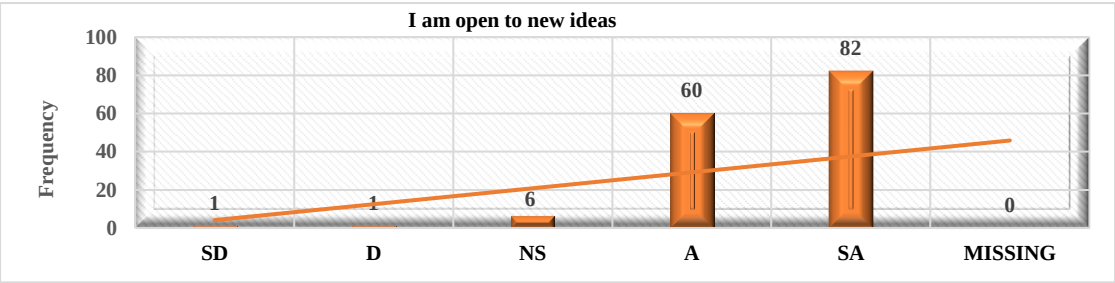


Figure 5.38: The summary of students' responses to the "I am open to new ideas" sub factor

A glance at this graph clearly shows that the most frequent choice on the Likert scale is the "SA" (N = 82; 54.67%) option, followed by the "A" (N = 60, 40%) option. The bar graph (see figure 5.16) thus displays a negatively skewed distribution of data. From this distribution, it can thus be deduced that the majority of the participants (N= 142; 94.67), agreed with the idea of being open to new ideas.

Question DML6: When presented with a problem I cannot resolve, I always ask for assistance.

The bar chart (figure 5.39) provides a visual depiction of the "When presented with a problem I cannot resolve, I always ask for assistance" distribution question.

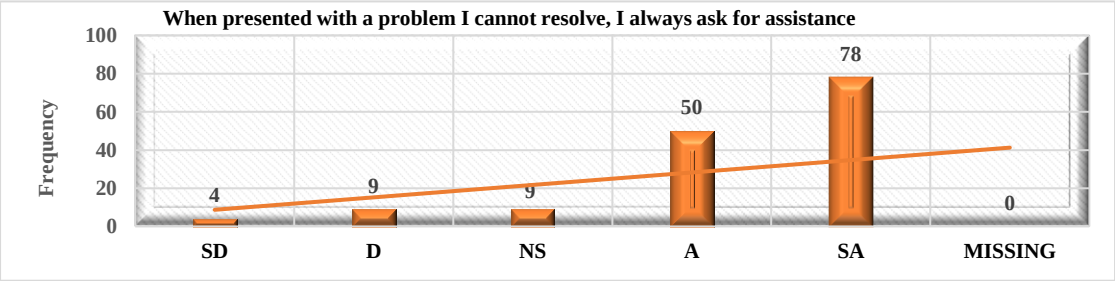
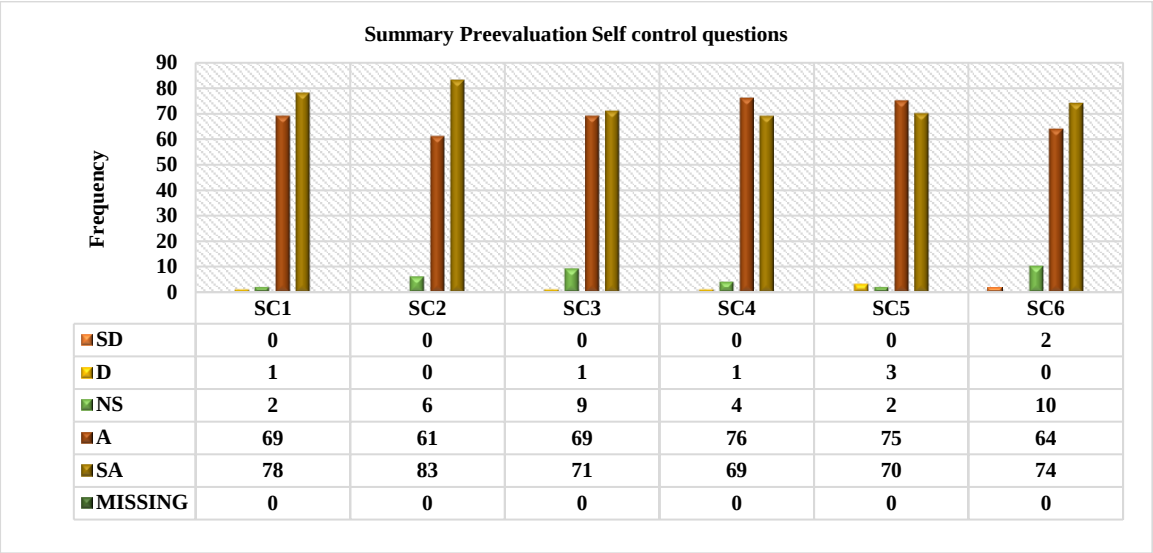


Figure 5.39: The summary of students' responses to the "When presented with a problem I cannot resolve, I always ask for assistance" sub factor

A glance at this graph clearly shows that the most frequent choice on the Likert scale is the "SA" (N = 78; 52%) option, followed by the "A" (N = 50, 33.33%) option. The trendline on the graph (see figure 5.39) displays a negatively skewed data distribution. This is because most of the data are on the higher scores. The inference that can be made from this distribution is that the majority of the participants (N = 128; 85.33%), are now comfortable with asking for assistance when faced with complex mathematical problems.

5.3.3 Findings emerging from Sub Factor 3: Self-Control

The summary of the participants' responses to all the questions in this sub factor are displayed in the bar chart (see figure 5.40).



	SC1	SC2	SC3	SC4	SC5	SC6
SD	0	0	0	0	0	2
D	1	0	1	1	3	0
NS	2	6	9	4	2	10
A	69	61	69	76	75	64
SA	78	83	71	69	70	74
MISSING	0	0	0	0	0	0

Figure 5.40: The summary of students' responses to the "Self-Control" sub factor

The bar graph (figure 5.40) displays the average responses for the whole "self-control" sub factor. An analysis of the data reveals that, on average, 74 students (49.33%) strongly agreed that that they have good self-control skills needed for self-directed learning. 69 students (46%) agreed, 1 student (0.67%) disagreed, and 33 students (22%) were undecided. The percentage of those who agreed (95.33%) is far higher than the moderate level as recommended by El Seesya, Sofar and Al-Battawi (2017). According to El Seesya, *et al*. (2017), scores below 50 % show low SDL readiness, scores from 50% to less than 75% show moderate SDL readiness while scores from 75% show high SDL readiness.

The mean score of the participants for "self-control" sub factor is 4.44, the standard deviation was 0.62 and the variance 0.39 while the modal score is 5. The mean data analysis also shows a relative standard deviation (RSD) of 4.4 ± 13.9%. The 13.9% confirms a low relative standard deviation which means the participants' choices are closer to the mean. Accordingly, the students now have high positive self-control skills needed for online self-directed learning. The high level of self-control is an indication that students have positive attitude towards SDL (Hill, Peters, Salvaggio, Vinnedge & Darden, 2020). The next sub-section presents the self-control factor analysis, students' responses per question:

Question SC1: I prefer to set my own learning goals

The bar chart (figure 5.41) provides a visual depiction of "I prefer to set my own learning goals" distribution question.

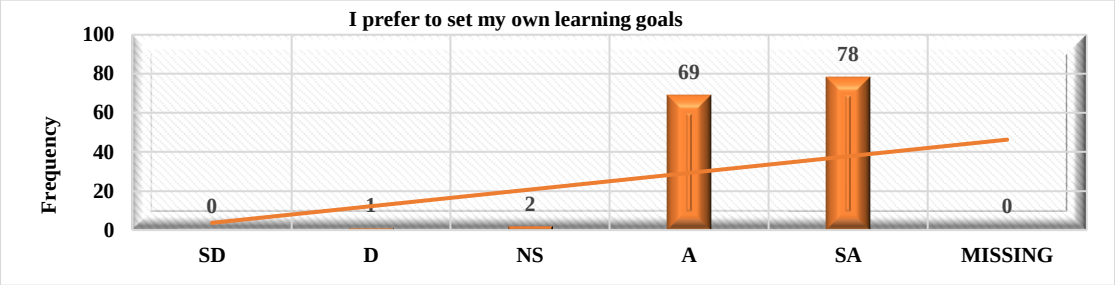


Figure 5.41: The summary of students' responses to the "I prefer to set my own learning goals" sub factor

Data analysis of this sub factor clearly shows that the most frequent choice on the Likert scale is the "SA" (N = 78; 52%) option. This is followed by the "A" (N = 69; 46%) option. This means that most students prefer to set their own learning goals. Schippers *et al*., (2020) argue that:

> …students who set their own working goals tend to achieve more than when working on goals set for them by the teacher. Students who set their own learning goals have more confidence to take on more challenging tasks, regardless of their ability.

Their self-esteem remains high even in the face of failure, which increases their motivation to learn and master a task.

Question SC2: I like to make decisions for myself

The bar chart (figure 5.42) provides a visual depiction of "I like to make decisions for myself" distribution question.

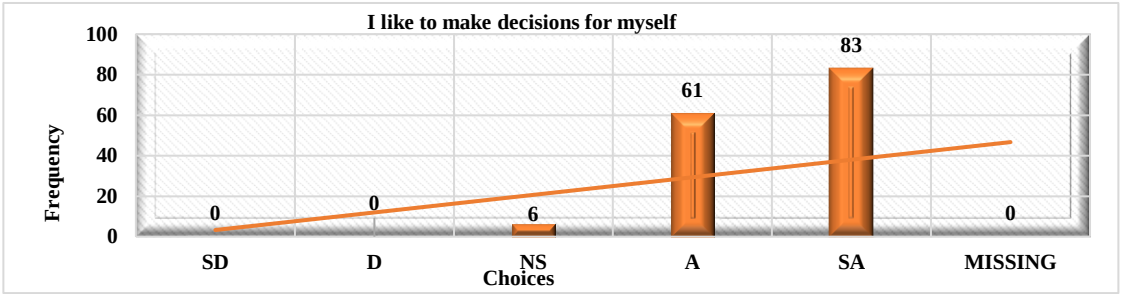


Figure 5.42: The summary of students' responses to the "I like to make decisions for myself" sub factor

When analysing the data, one is able to note that the most frequent choice on the Likert scale is the "SA" (N = 83; 53.33%) option, followed by "A" (N = 61, 40.67%) option. The bar graph

trendline (see figure 5.42) shows a negatively skewed data distribution. This distribution tells that the majority of the participants (N = 144; 96%), now could make their own decisions. This is because there are many choices on the higher scores.

Question SC3: I always set high personal standards

The bar chart (figure 5.43) provides a visual depiction of "I always set high personal standards" distribution question.

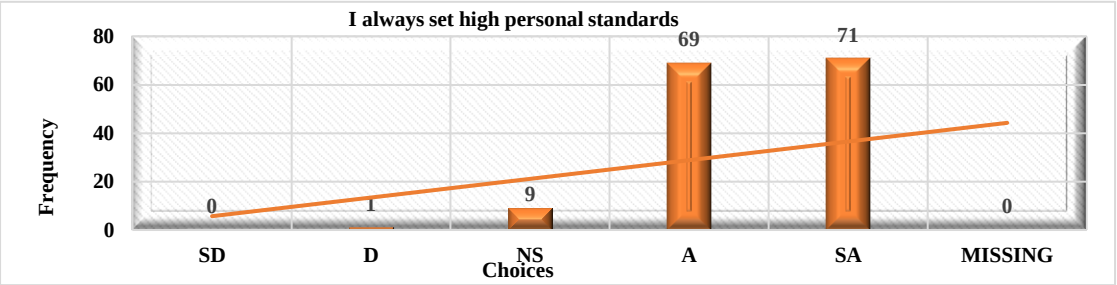


Figure 5.43: The summary of students' responses to the "I always set high personal standards" sub factor

Data analysis in this question reveals the most frequent choice on the Likert scale is the "SA" (N = 71; 47.33%) option, followed by "A" (N = 69, 46%). The bar graph (see figure 5.43) clearly shows a negatively skewed data distribution. From this distribution, it can thus be deduced that most of the participants (N = 140; 93.33), now prefer to set high personal standards. This is good because university students are expected to be active and creative thinkers, with the ability and competence to develop their own personal standards.

Question SC4: I evaluate my own performance

The bar chart (figure 5.44) provides a visual depiction of "I evaluate my own performance" distribution question.

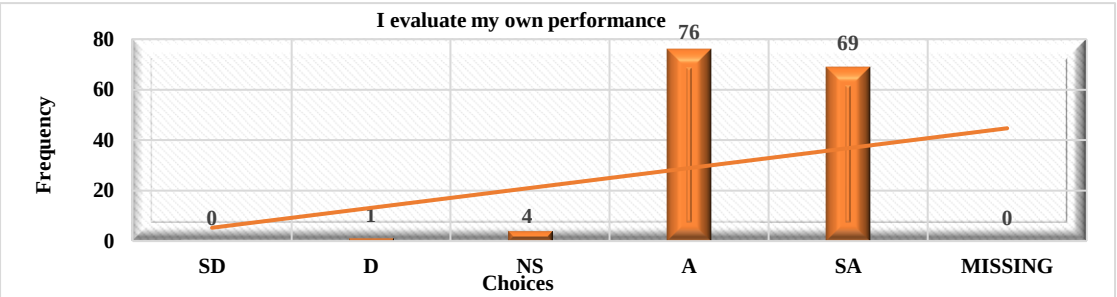


Figure 5.44: The summary of students' responses to the "I evaluate my own performance" sub factor

Data analysis reveals that the most selected option is the "A" (N = 76; 50.67%) option. The data distribution on the graph (see figure 5.44), clearly shows that more data fall toward the higher side

of the scale and there are very few lower scores. Data distribution is therefore negatively skewed. This distribution tells that many of the students who participated in this study have now developed the competency and passion to evaluate their own performance. In order to become lifelong learners, university students need these self-evaluation and self-reflection skills. This will assist them in monitoring their own progress when learning.

Question SC5: I can find out information for myself

The bar chart (figure 5.45) provides a visual depiction of "I can find out information for myself" distribution question.

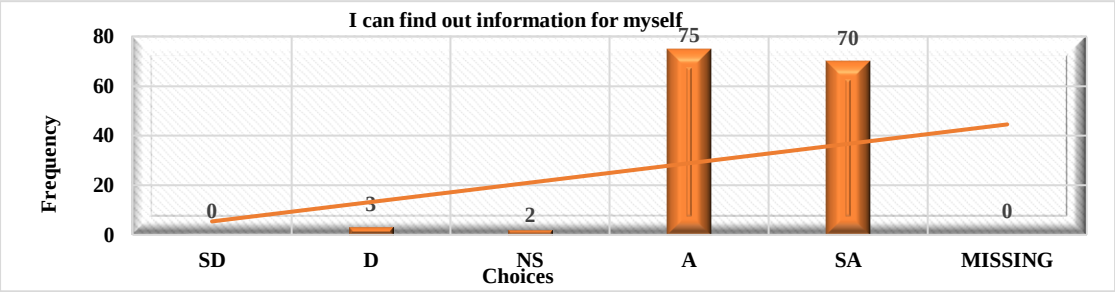


Figure 5.45: The summary of students' responses to the "I can find out information for myself" sub factor

Statistical data analysis clearly shows that the most frequent choice on the Likert scale is "A" (N = 75; 50%) option, followed by "SA" (N = 70, 46.67%) option. The least choice was Strongly Agree (N = 8; 5.33%). From the trendline on the graph (figure 5.45), we can clearly see that the data distribution is left skewed. Most scores fall towards the higher side of the scale and there are very few lower scores. From this distribution, it can thus be deduced that most of the participants (N = 145; 96.67%), have developed the skills and competencies to find information on their own. University students are expected to have their own self-study skills, which will assist them to be able to go beyond simply learning what their lecturers teach them.

Question SC6: I prefer to set my own criteria on which to evaluate my performance

The bar chart (figure 5.46) provides a visual depiction of "I prefer to set my own criteria on which to evaluate my performance" distribution question.

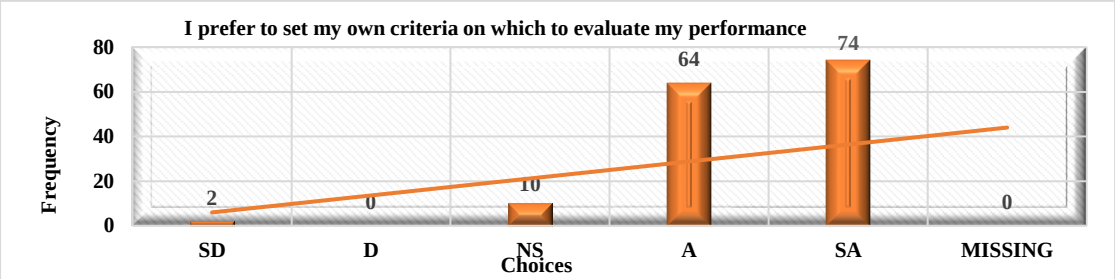
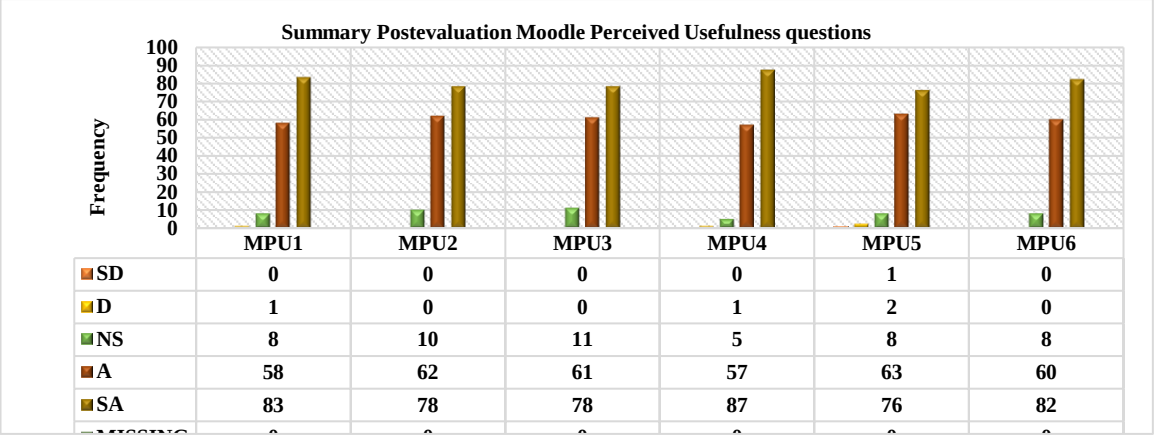


Figure 5.46: The summary of students' responses to the "I prefer to set my own criteria on which to evaluate my performance" sub factor

Upon analysing the data in this question, it was revealed that the most frequent choice on the Likert scale is "SA" (N = 74; 49.33%) option, followed by "A" (N = 64, 42.67%) option. The data on the graph (see figure 5.46), display a skewed distribution to the left, which is said to be negative. This is because most scores fall toward the higher side of the scale and there are very few lower scores. From this distribution, it can thus be deduced that most of the participants (N = 138; 92%), have developed the competency to set their own criteria on which to evaluate their performance. Setting their own criteria will go a long way in assisting students to identify their own skill gaps.

5.3.4 Findings emerging from Moodle Perceived Usefulness sub factor

In this item students were asked to give their rank of opinions towards Moodle Perceived Usefulness. In the context of this study, Moodle Perceived Usefulness refers to the degree to which a student believes that the use of Moodle will improve his/her performance. Students were asked to indicate how Moodle helps them to learn more efficiently and effectively, how Moodle improves their academic performance, how Moodle makes it easier for them to learn at university, how Moodle gives them control over their learning, and how Moodle is advantageous to their learning. The summary of their responses to all the questions in this sub factor are displayed in bar graph, figure 5.47.



	MPU1	MPU2	MPU3	MPU4	MPU5	MPU6
SD	0	0	0	0	1	0
D	1	0	0	1	2	0
NS	8	10	11	5	8	8
A	58	62	61	57	63	60
SA	83	78	78	87	76	82

Figure 5.47: Summary of the post evaluation Moodle perceived usefulness questions

The data reveal that on average, 141 students (94%) either strongly agreed or agreed that Moodle is a very useful LMS, 8 students (5.33%) were not sure, while only 1 student (0.67%) disagreed. The high percentage of the students who either strongly agreed or agreed tells that the post evaluation intervention had a positive effect on students online teaching and learning. This is an indication that students now have independent and online technological skills needed for self-directed learning. The mean score of the participants for the "Moodle Perceived Usefulness" sub factor was 4.47, the standard deviation was 0.63 and the variance was 0.49 and the mode was 5. The mean is closer to the highest score on the Likert scale. The mean data analysis also shows a relative standard deviation (RSD) of 4.5 ± 14.14%. The 4.5% confirms a low relative standard deviation which means the participants' choices are closer to the mean. Accordingly, the students who completed the questionnaire now perceive Moodle as a good LMS. High positive Moodle attitude level is an indication that students have positive attitude towards SDL (Cabero-Almenara, Arancibia and Del Prete, 2019). The next sun-section highlights Moodle perceived usefulness, students' responses per question:

Question MPU1: Moodle helps me to learn more efficiently

The bar chart (figure 5.48) provides a visual depiction of the "Moodle helps me to learn more efficiently" distribution question.

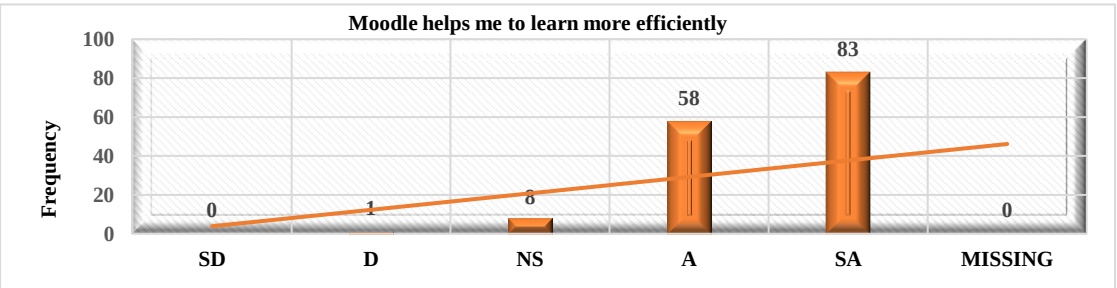


Figure 5.48: The summary of students' responses to the "Moodle helps me to learn more efficiently" sub factor

This question tested the students' perceptions on how Moodle helps them to learn more efficiently. The data shows that the most frequent choice is "SA" option (N = 83; 53.33%), followed by the "A" option (N = 58; 38.67%). 94% of the respondents therefore agree that Moodle helps them to learn more efficiently. The data distribution on the graph (see figure 5.48), clearly shows that more data fall toward the higher side of the scale and there are very few lower scores. Data distribution is therefore negatively skewed. From this distribution, it can thus be deduced that most respondents (N = 141; 94%), have developed a strong confidence in Moodle teaching and learning. These are good results for self-directed learning.

Question MPU2: **Moodle improves my academic performance**

The bar chart (figure 5.49) displays a visual depiction of the "Moodle improves my academic performance" distribution question.

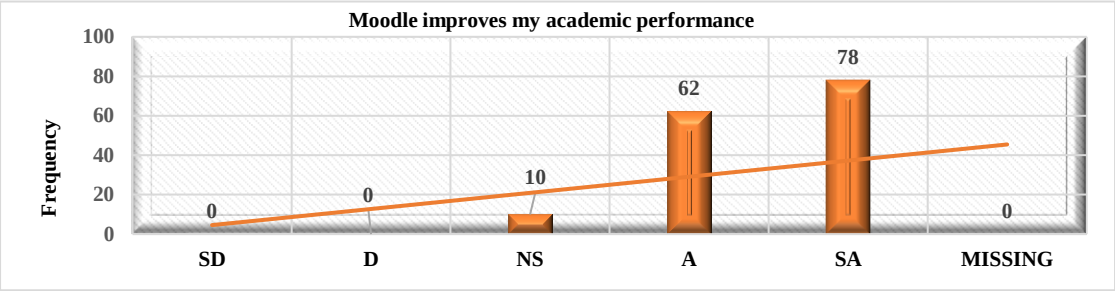


Figure 5.49: The summary of students' responses to the "Moodle improves my academic performance" sub factor

This question tested the students' perceptions on how Moodle improves their academic performance. The data analysis of the "Moodle improves my academic performance" sub factor shows that the most frequent choice is the "SA" option (N = 78; 52%), followed by the "A" (N = 62; 41.33%) option. The trend line on the graph (see figure 5.49) shows that data are negatively skewed with most scores falling toward the higher side of the scale and there are very few lower scores. From this distribution, it can thus be deduced that the majority of the respondents (N = 140; 93.33) now believe that Moodle improves their academic performance.

Question MPU3: **Moodle makes my learning more effective**

The bar chart (figure 5.50) displays a visual depiction of the "Moodle makes my learning more effective" distribution question.

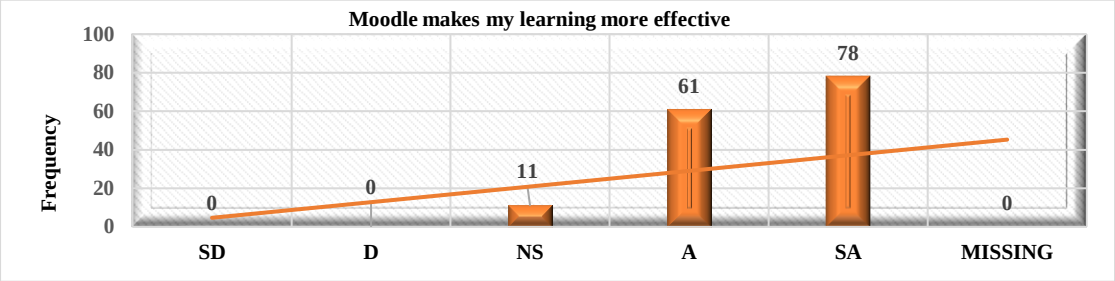


Figure 5.50: The summary of students' responses to the "Moodle makes my learning more effective" sub factor

This question assessed the students' perceptions on how Moodle was able to make their learning more effective. The data analysis clearly shows that the most frequent choice on the Likert scale is "SA" (N = 78; 52%) option, followed by "A" (N = 61, 40.67%) option. The trend line on the graph (see figure 5.50) shows negatively skewed data. The inference that can be made from this distribution is that the majority of the participants (N = 139; 92.67%), have now developed a positive attitude towards Moodle as it makes their online learning more effective.

Question MPU4: **Moodle makes it easier to learn at university**

The bar chart (figure 5.51) provides a visual depiction of the "Moodle makes it easier to learn at university" distribution question.

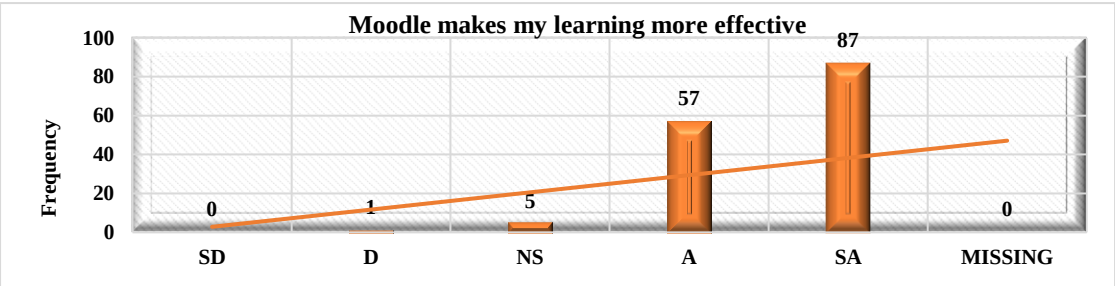


Figure 5.51: The summary of students' responses to the "Moodle makes it easier to learn at university" sub factor

This question tested the students' perceptions on how Moodle makes it easier for them to learn at university. A glance at this graph clearly shows that the most frequent choice on the Likert scale is "SA" (N = 87; 58%) option, followed by "A" (N = 57, 38%) option. The data distribution on the graph (see figure 5.51), clearly shows that more data fall towards the higher side of the scale

and there are very few lower scores. Data distribution is therefore negatively skewed. From this distribution, it can thus be deduced that most of the participants (N = 144; 96%), believe that Moodle makes it easier for them to learn at university.

***Question MPU5:* Moodle gives me control over my learning**

The bar chart (figure 5.52) provides a visual depiction of the "Moodle gives me control over my learning" distribution question.

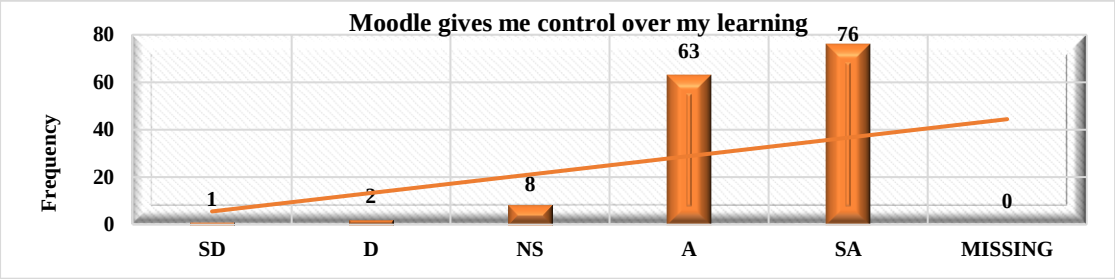


Figure 5.52: The summary of students' responses to the "Moodle gives me control over my learning" sub factor

This question tested the students' ability on how Moodle gives them control over their learning. Data analysis on this question clearly shows that the most frequent choice on the Likert scale is "SA" (N = 76; 50.67%) option, followed by "A" (N = 63, 42%) option. The bar graph (see figure 5.52) clearly displays a distribution with many high scores. Data distribution is therefore negatively skewed. The inference that can be made from this distribution is that most of the participants (N = 149; 99.33), believe that Moodle helps them to control their own learning.

***Question MPU6:* Overall, Moodle is advantageous for my learning**

The bar chart (figure 5.53) provides a visual depiction of the "Overall, Moodle is advantageous for my learning" distribution question.

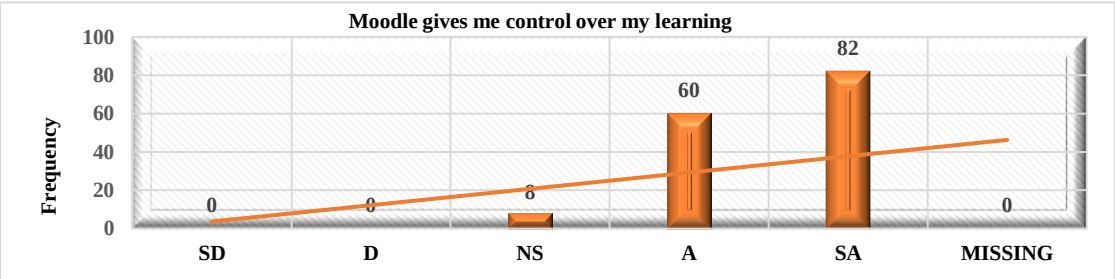


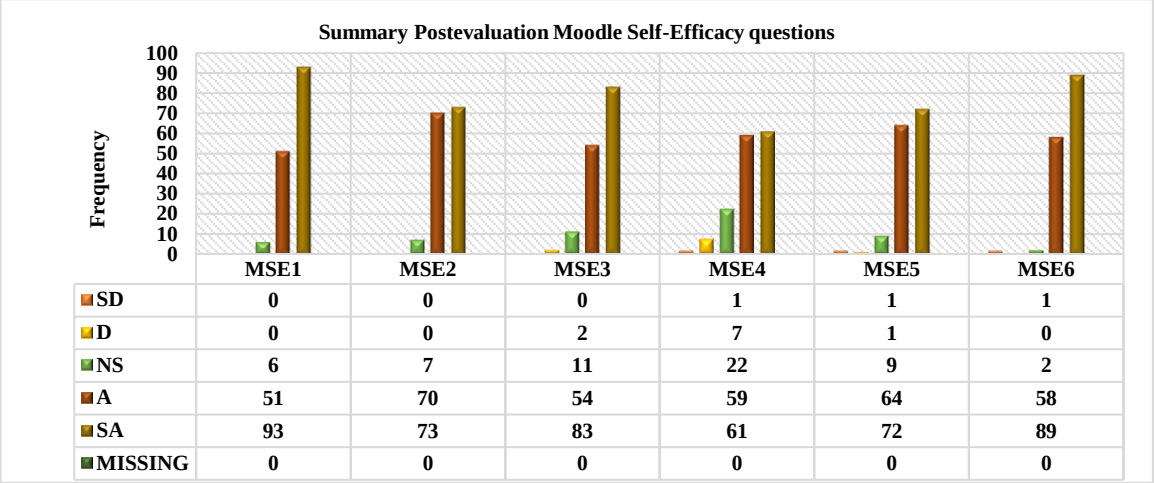
Figure 5.53: The summary of students' responses to the "Overall, Moodle is advantageous for my learning" sub factor

This question tested the students' perceptions on how Moodle is advantageous to their learning. Upon analysing the data, it was revealed that most students (N=82; 54.67%) are now confident

that Moodle is advantageous to their learning. The data distribution on the graph (see figure 5.53), displays a skewed distribution to the left, which is said to be negative. This is because most scores fall towards the higher side of the scale and there are very few lower scores. From this distribution, it can thus be deduced that the majority of students (N = 142; 94.67%) believe that Moodle is advantageous for their learning.

5.3.5 Findings emerging from Moodle Self-Efficacy sub factor

In this item students were asked to give their rank of opinions towards Moodle self-efficacy. Moodle Self-efficacy refers to students' confidence (or lack thereof) when using Moodle as LMS. In this sub factor, students were asked, on a 5-point Likert-scale, to indicate their perceptions on Moodle self-efficacy, with respect to accessing the Moodle content, the navigation of Moodle content, the solving problems that arise on Moodle, and using Moodle when there are user manuals available. The summary of their responses to all the questions in this sub factor is displayed in the bar graph, figure 5.54.



	MSE1	MSE2	MSE3	MSE4	MSE5	MSE6
SD	0	0	0	1	1	1
D	0	0	2	7	1	0
NS	6	7	11	22	9	2
A	51	70	54	59	64	58
SA	93	73	83	61	72	89
MISSING	0	0	0	0	0	0

Figure 5.54: Summary of the post evaluation Moodle self-efficacy questions

The bar graph (figure 5.54) displays the average response for the whole "Moodle Self-Efficacy" sub factor. Data analysis depicts that on average, 78 students (52%) strongly agreed while 59 students (39.33%) agreed that they had a desire for mathematical learning. Only 1 student (0.67%) strongly disagreed, 2 students (1.33%) disagreed, while 10 students (6.67%) were undecided. The data analysis therefore shows that most of the students (N = 137; 91.33%) have high positive self-efficacy towards Moodle.

The mean score of the participants for "Moodle Self-Efficacy" sub factor was 4.43, the standard deviation was 0.67 and the variance was 0.46 and the modal score was 5. The mean and the mode are closer to the highest score on the Likert scale. The mean data analysis also shows a relative standard deviation (RSD) of 4.4 ± 15.1%. The 15.1% confirms a low relative standard deviation which means the participants' choices are closer to the mean. This confirms that students' self-efficacy towards Moodle is high. Accordingly, the students now have a positive Moodle self-efficacy needed for online self-directed learning. High positive Moodle self-efficacy is an indication that students have positive attitude towards SDL (Kerimbayev, Kultan, Abdykarimova and Akramova, 2017).

Question MSE1: **I can access the contents of Moodle**

The bar chart (figure 5.55) provides a visual depiction of "I can access the contents of Moodle" distribution question.

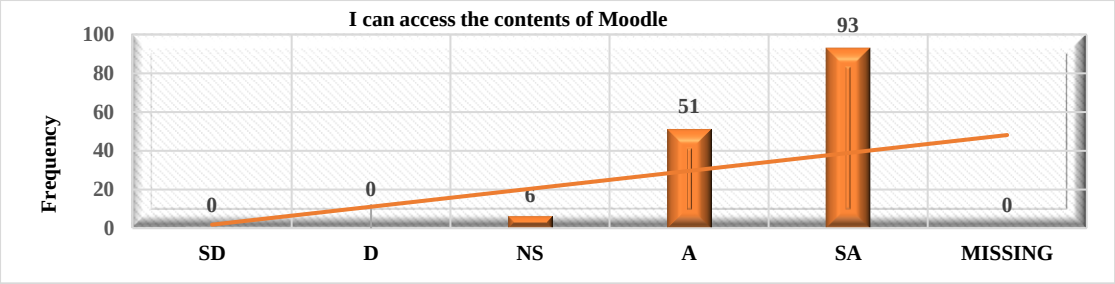


Figure 5.55: The summary of students' responses to the "I can access the contents of Moodle" sub factor

This question tested the students' perceptions towards accessing the contents of Moodle.

The statistical data analysis of "I can access the contents of Moodle" sub factor shows that the most frequent choice is "SA" (N = 93; 62%) option, followed by the "A" (N = 51; 34%) option. The trendline on the graph (see figure 5.55) displays a negatively skewed data. This is because most of the data are on the higher scores. The inference that can be made from this distribution is that the majority of the participants (N = 144; 96%) have high positive perceptions towards accessing the contents of Moodle. The analysis therefore shows that most students can now access Moodle contents on their own, which is a sign of their journey towards self-directed learning.

Question MSE2: **I can freely navigate the contents of Moodle.**

The bar chart (figure 5.56) provides a visual depiction of "I can freely navigate the contents of Moodle" distribution question.

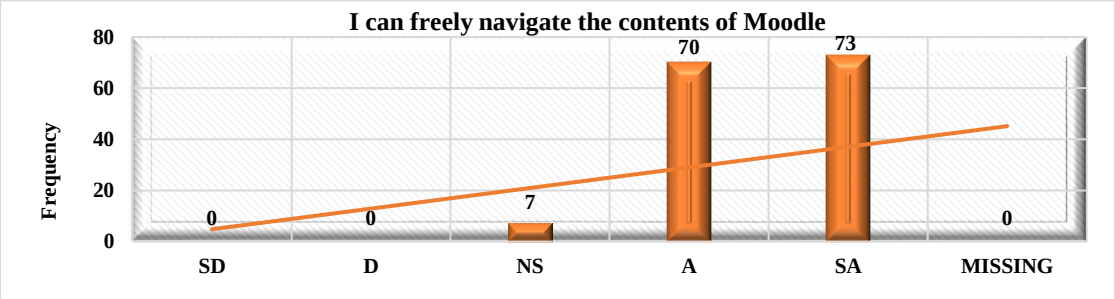


Figure 5.56: The summary of students' responses to the "I can freely navigate the contents of Moodle" sub factor

This question tested the students' perceptions towards freely navigating the contents of Moodle. The data analysis of "I can freely navigate the contents of Moodle" sub factor shows that the most frequent choice on the Likert scale is "SA" (N = 73; 48.67%) option, followed by the "A" (N = 70, 46.67%) option. The data distribution on the graph (see figure 5.20), clearly shows that the majority of the participants (N = 143; 95.33%), can now freely navigate the contents of their Moodle platforms. This is because there are many choices on the lower scores.

Question MSE3: **I can use Moodle without needing to be told how it functions**

The bar chart (figure 5.57) provides a visual depiction of "I can use Moodle without needing to be told how it functions" distribution question.

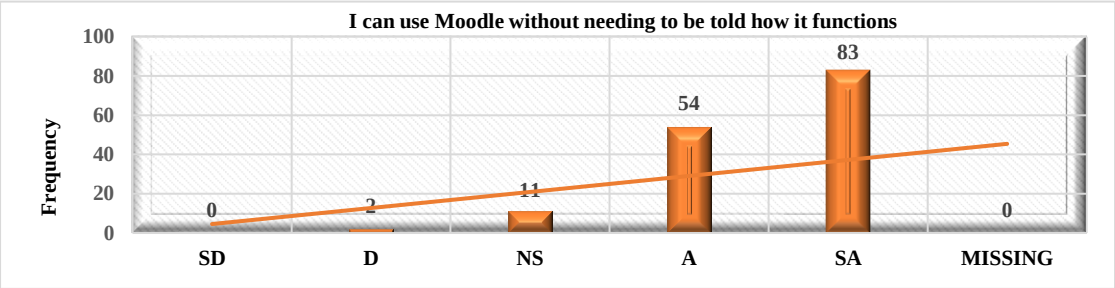


Figure 5.57: The summary of students' responses to the "I can use Moodle without needing to be told how it functions" sub factor

This question tested the students' views on whether they can now use Moodle without the lecturer's instructions on how it functions. The most frequent choice is the "SA" (N = 83; 55.33%) option, followed by the "A" (N = 54, 36%) option. The bar graph data (see figure 5.57), clearly displays a negatively skewed data distribution. From this distribution, it can thus be deduced that **most** of the participants (N = 137; 91.33%) can now use Moodle independently of the lecturer's guidance.

***Question MSE4:* I can solve problems that arise on Moodle**

The bar chart (figure 5.58) provides a visual depiction of the "I can solve problems that arise on Moodle" distribution question.

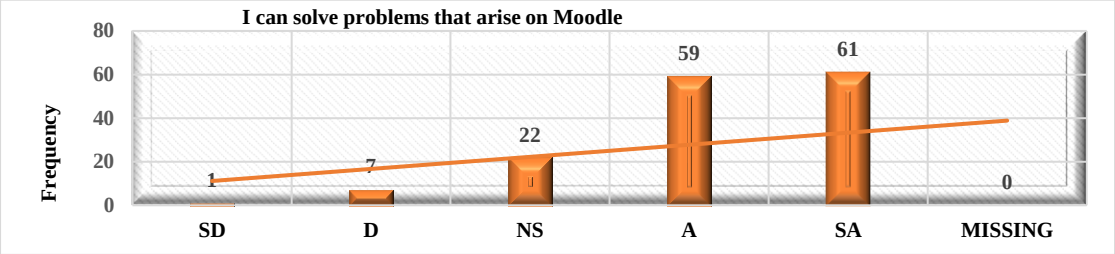


Figure 5.58: The summary of students' responses to the "I can solve problems that arise on Moodle" sub factor

This question tested the students' views on solving the problems that arise on Moodle. Students' responses to this question show a high degree in terms of the ability to solve the problems that arise on Moodle on their own. A glance at this graph clearly shows that the most frequent choice on the Likert scale is "SA" (N = 61; 40.67%) option, followed by the "A" (N = 59, 39.33%) option. The data distribution on the graph (see figure 5.58), clearly shows that more data fall toward the higher side of the scale and there are many higher scores. Data distribution is therefore negatively skewed. This distribution tells that many of the students who participated in this study now have the competency to solve problems that arise on Moodle.

Question MSE5: I can use Moodle if there are user manuals available

The bar chart (figure 5.59) provides a visual depiction of "I can use Moodle if there are user manuals available" distribution question.

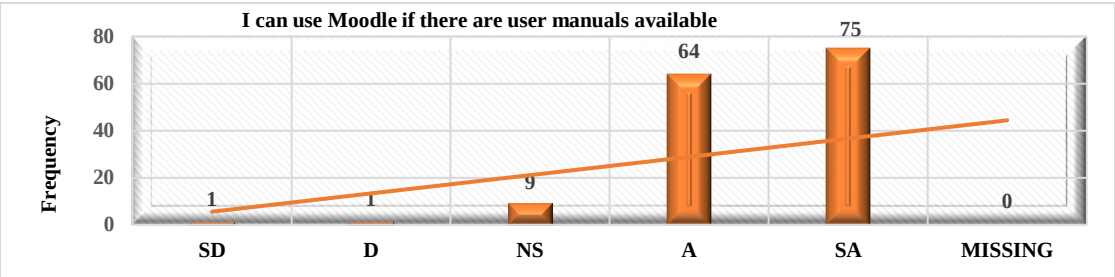


Figure 5.59: The summary of students' responses to the "I can use Moodle if there are user manuals available" sub factor

This question tested the students' views on the competency of using Moodle if there are user manuals available. A glance at this graph clearly shows that the most frequent choice on the Likert scale is the "SA" (N = 75; 50%) option, followed by the "A" (N = 64, 42.67%) option. From the trendline on the graph (figure 5.59) we can clearly see that the data is left skewed. Most scores

fall towards the higher side of the scale and there are many higher scores. From this distribution, it can thus be deduced that students can comfortably use Moodle if there are user manuals available.

Question MSE6: **Overall, I am able use Moodle**

The bar chart (figure 5.60) provides a visual depiction of the "Overall, I am able to use Moodle" distribution question.

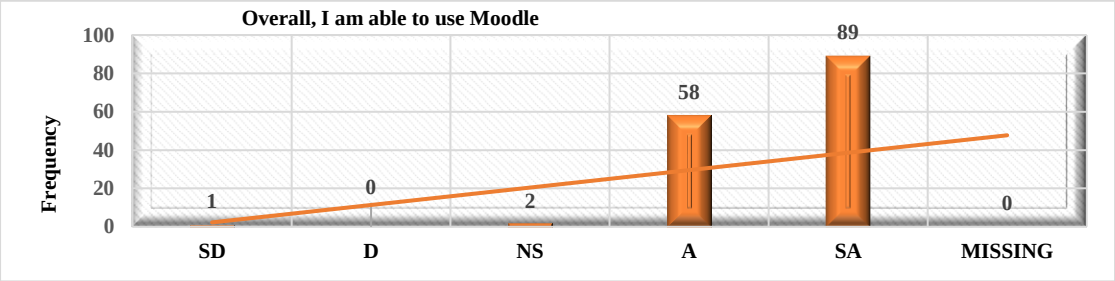
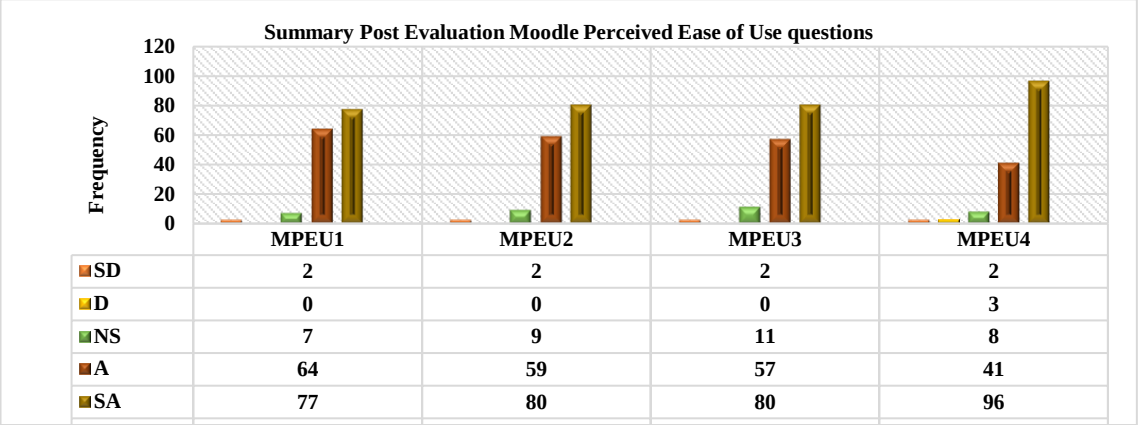


Figure 5.60: The summary of students' responses to the "Overall, I am able to use Moodle" sub factor

This question tested the students' overall views on their competency to use Moodle. A glance at this graph clearly shows that the most frequent choice on the Likert scale is the "SA" (N = 89; 59.33%) option, followed by the "A" (N = 58, 38.67%) option. The trendline on the graph (see figure 5.60) displays a negatively skewed data. This is because most of the data are on the higher scores. The inference that can be made from this distribution is that most of the participants' (N = 147; 98%), overall views on their competency to use Moodle is high.

5.3.6 Findings emerging from Moodle Perceived Ease of Use

In this item students were asked to rank their opinions towards Moodle perceived ease of use. According to Jonas and Norman (2011), "Moodle perceived ease of use refers to the degree to which a person believes that engaging in Moodle online transactions would be free of effort". In this sub factor, students were asked, on a 5-point Likert-scale, to indicate their perceptions on how easy to use Moodle, how easy to get materials from Moodle, how clear and understandable is the process of using Moodle.



	MPEU1	MPEU2	MPEU3	MPEU4
SD	2	2	2	2
D	0	0	0	3
NS	7	9	11	8
A	64	59	57	41
SA	77	80	80	96

Figure 5.61: Summary of Post Evaluation Moodle Perceived Ease of Use

The bar graph (figure 5.61) displays the average responses for the whole "Moodle Perceived Ease of Use" sub factor. Data analysis shows that on average, 83 students (55.3%) strongly agreed that that they perceived the use of Moodle to be easy and therefore user friendly. 55 students (36.7%) agreed, 1 student (0.7%) disagreed, 2 students (1.3%) strongly disagreed, and 9 students (6%) were undecided.

The mean score of the participants for "Moodle Perceived Ease of Use" sub factor is 4.44, the standard deviation 0.75 and the variance 0.56 and the modal score 5. The mean and the mode are closer to the highest score on the Likert scale. The mean data analysis also shows a relative standard deviation (RSD) of 4.4 ± 16.8%. The 16.8% show a low relative standard deviation which means the participants' choices are closer to the mean. This tells that students now perceive Moodle as an easy LMS to use in their learning. The perceived ease of Moodle use is an indication that students have positive attitude towards online self-directed learning (Cabero-Almenara, Arancibia & Del Prete, 2019).

Question MPEU1: **Learning to use Moodle is easy for me**

The bar chart (figure 5.62) provides a visual depiction of the "Learning to use Moodle is easy for me" distribution question.

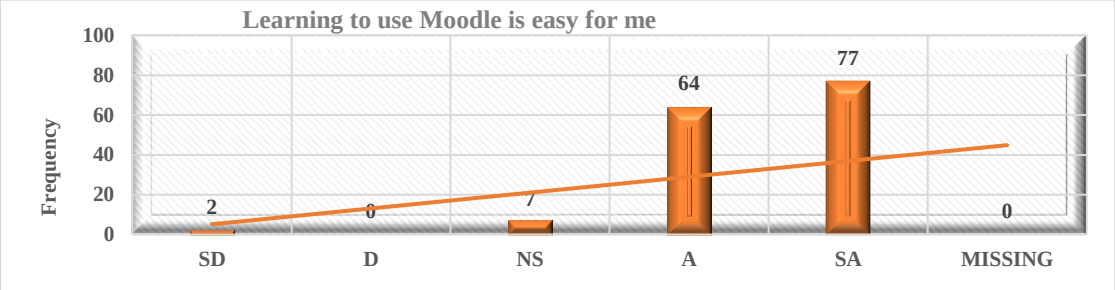


Figure 5.62: The summary of students' responses to the "Learning to use Moodle is easy for me" sub factor

This question tested the students' perceptions on the learning of how to use Moodle. Data analysis of this sub factor clearly shows that the most frequent choice on the Likert scale is the "SA" (N = 77; 51.33%) option. This is followed by the "A" (N = 64; 42.67%) option. The trend line on the graph (see figure 5.62) shows that data distribution is negatively skewed with most scores falling toward the higher side of the scale and there are many higher scores. From this distribution, it can thus be deduced that **most** of the participants (N = 141; 94%), now find it easy to use Moodle.

Question MPEU2: **It is easy to get materials from Moodle**

The bar chart (figure 5.63) provides a visual depiction of the "It is easy to get materials from Moodle" distribution question.

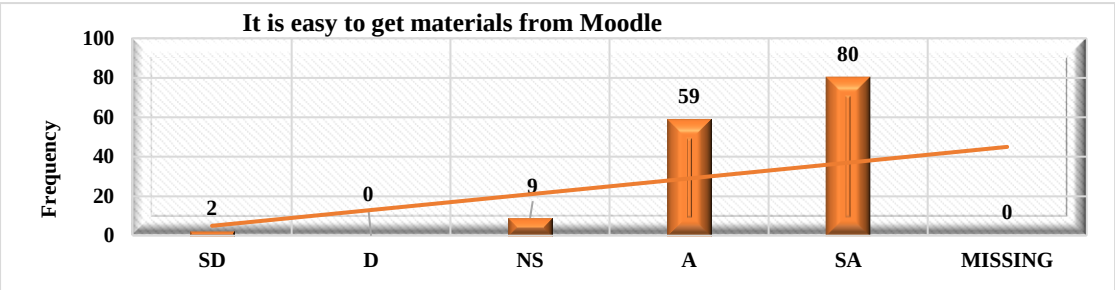


Figure 5.63: The summary of students' responses to the "It is easy to get materials from Moodle" sub factor

This question tested the students' perceptions on how to access learning materials from Moodle. Upon analysing the data, it was revealed that the most frequent choice on the Likert scale is the "SA" (N = 80; 53.33%) option, followed by "A" (N = 59, 39.33%) option. The trendline on the graph (see figure 5.63) displays a negatively skewed data. This is because most of the data are on

the higher scores. The inference that can be made from this distribution is that most of the participants (N = 139; 92.67%), find it easy to access learning materials from Moodle.

Question MPEU3: **The process of using Moodle is clear and understandable**

The bar chart (figure 5.64) provides a visual depiction of "The process of using Moodle is clear and understandable" distribution question.

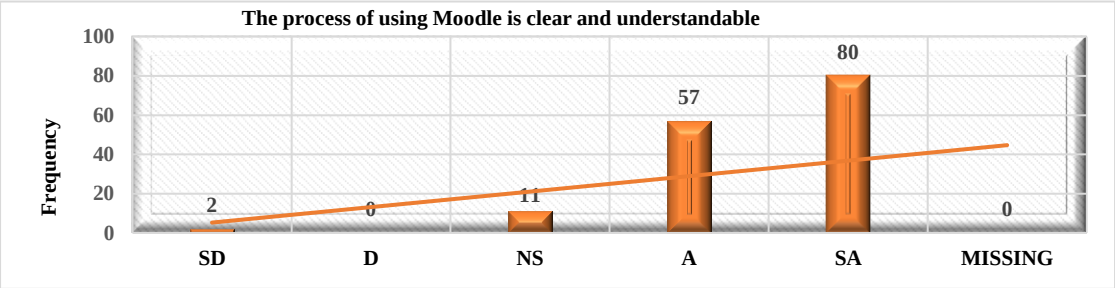


Figure 5.64: The summary of students' responses to the "The process of using Moodle is clear and understandable" sub factor

This question tested the students' understanding of the process of using Moodle. Data analysis in this question reveals the most frequent choice on the Likert scale is the "SA" (N = 80; 53.33%) option, followed by "A" (N = 57, 38%). From the trendline on the graph (figure 5.64) we can clearly see that the data is left skewed. Most scores fall toward the higher side of the scale and there are very few lower scores. From this distribution, it can thus be deduced that the participants (students) now understand the whole process of using Moodle.

Question MPEU4: **Overall, I believe that Moodle is easy to use**

The bar chart (figure 5.65) provides a visual depiction of the "Overall, I believe that Moodle is easy to use" distribution question.

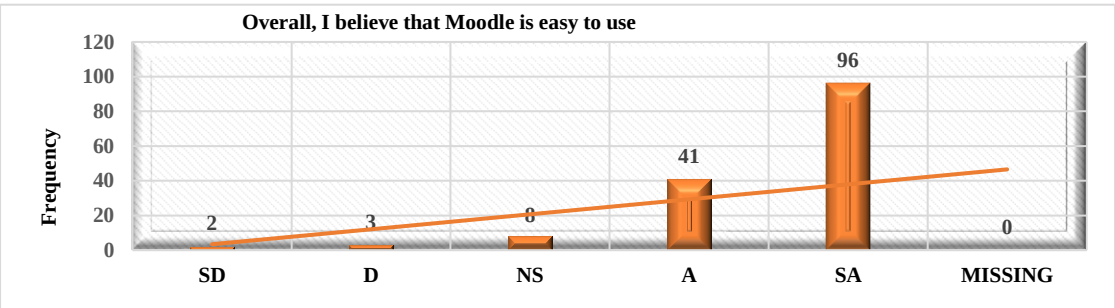


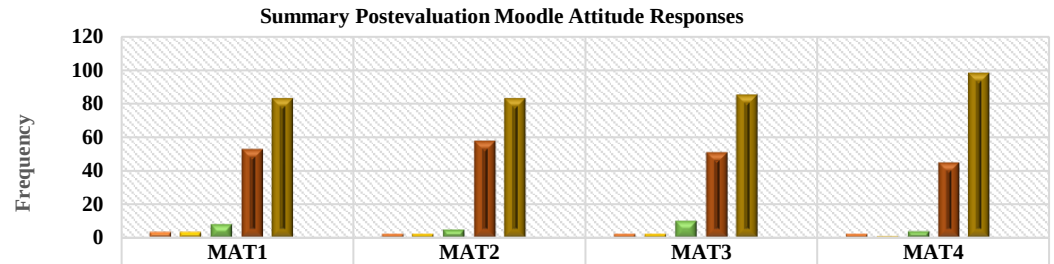
Figure 5.65: The summary of students' responses to the "Overall, I believe that Moodle is easy to use" sub factor

This question tested the students' perceptions on the Overall usability of Moodle. Data analysis reveals that the most selected option was the "SA" (N = 96; 64%) option. The bar graph data distribution (see figure 5.65) clearly shows a negatively skewed data. From this distribution, it

can thus be deduced that most of the participants (N = 137; 91.33%), believe that Moodle is easy to use.

5.3.7 Findings emerging from Moodle Attitude sub factor

In this item students were asked to give their rank of opinions about their attitude on Moodle as an LMS. The summary of their responses to all the questions in this sub factor are displayed in bar graph (see figure 5.66).



	MAT1	MAT2	MAT3	MAT4
SD	3	2	2	2
D	3	2	2	1
NS	8	5	10	4
A	53	58	51	45
SA	83	83	85	98
MISSING	0	0	0	0

Figure 5.66: Post Evaluation Moodle Attitude Responses

The analysis of the data shows that on average, 139 students (92.67%) showed positive attitude towards Moodle. Only 4 students (2.67%) still had a negative attitude towards Moodle. The mean score of the participants for "Moodle Attitude" sub factor is 4.465, the standard deviation 0.77 and the variance 0.60 and the mode 5. The mean and the mode are closer to the highest score on the Likert scale. The mean data analysis also shows a relative standard deviation (RSD) of 4.5 ± 17.3%. The 17.3% show a low relative standard deviation which means the participants' choices are closer to the mean. Based on this analysis, it can thus be inferred that these students now have a high positive attitude towards the use of Moodle as an LMS. High positive Moodle attitude level is an indication that students have positive attitude towards SDL (Singh & Paudel, 2020).

Question MAT1: Learning using Moodle is fun

The bar chart (figure 5.67) provides a visual depiction of the "Learning using Moodle is fun" distribution question.

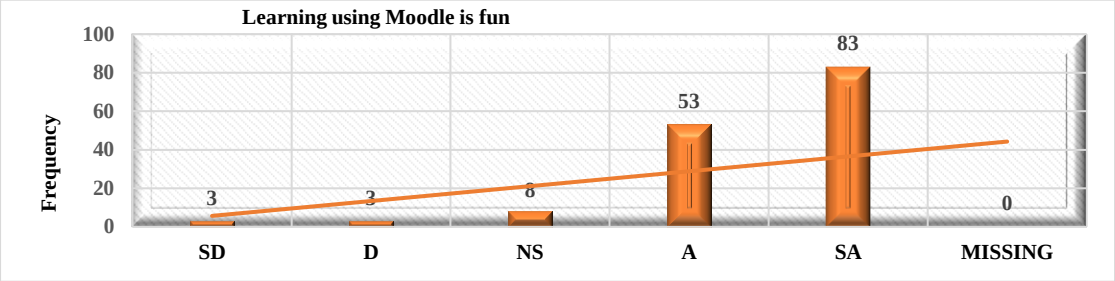


Figure 5.67: The summary of students' responses to the "Learning using Moodle is fun" sub factor

This question tested the students' perceptions on the learning of using Moodle. Data analysis clearly shows that the most frequent choice on the Likert scale is "SA" (N = 83; 55.33%) option, followed by "A" (N = 53, 35.33%) option. The trend line on the graph (see figure 5.67) shows that data distribution is negatively skewed with most scores falling toward the higher side of the scale and there are very few lower scores. From this distribution, it can thus be deduced that most of the participants (N = 136; 90.67%), now view learning using Moodle as fun.

Question MAT2: Using Moodle is a good idea

The bar chart (figure 5.68) provides a visual depiction of the "Using Moodle is a good idea" distribution question.

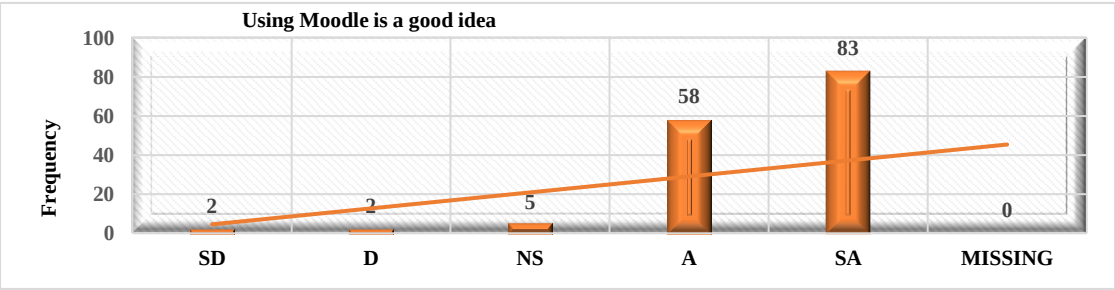


Figure 5.68: The summary of students' responses to the "Using Moodle is a good idea" sub factor

Upon analysing the data in this question, one observes that the most frequent choice on the Likert scale is "SA" (N = 83; 55.33%) option, followed by "A" (N = 58, 38.67%) option. From the trendline on the graph (figure 5.68) we can clearly see that the data distribution is right skewed. The inference that can be made from this distribution is that many students now find using Moodle to be a good idea.

***Question MAT3:* Using Moodle is an attractive way to learn**

The bar chart (figure 5.69) provides a visual depiction of "Using Moodle is an attractive way to learn" distribution question.

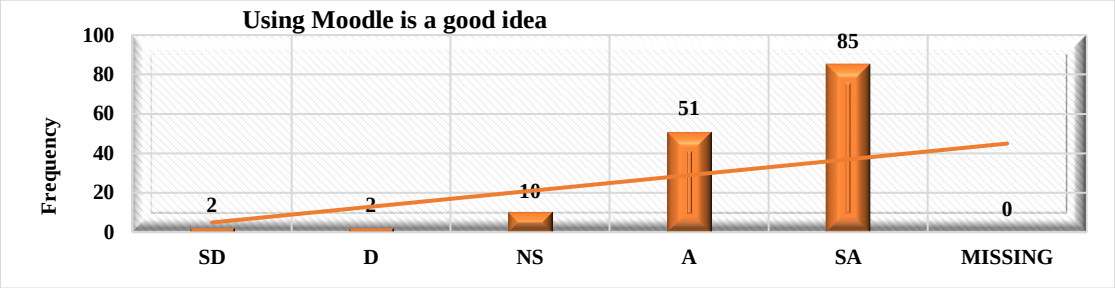


Figure 5.69: The summary of students' responses to the "Using Moodle is an attractive way to learn" sub factor

The data shows that the most frequent choice is "SA" option (N = 85; 56.67%), followed by the "A" option (N = 51; 34%). The trend line on the graph (see figure 5.12) shows negatively skewed data. What this distribution tells us is that more than three quarter of the participants now find using Moodle to be an attractive way to learn.

***Question MAT4:* Overall, I like using Moodle**

The bar chart (figure 5.70) provides a visual depiction of the "Overall, I like using Moodle" distribution question.

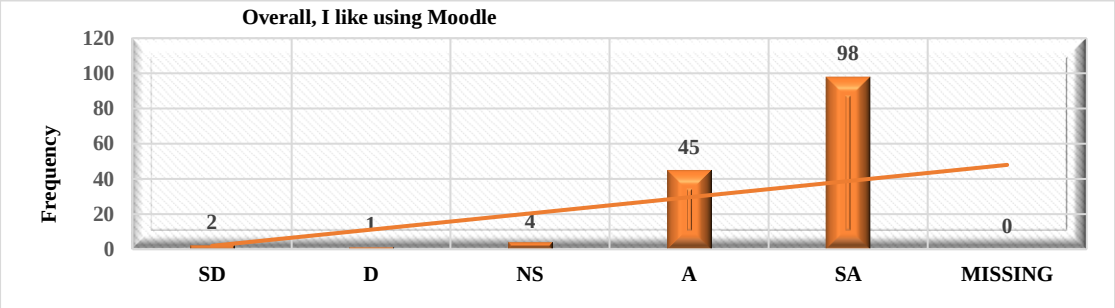


Figure 5.70: The summary of students' responses to the "Overall, I like using Moodle" sub factor

The data analysis as displayed in figure 5.70 shows that the most frequent choice is "SA" option (N = 98; 65.33%), followed by the "A" option (N = 45; 30%). The data distribution clearly shows that more data fall towards the higher side of the scale and there are very few lower scores. The data distribution is therefore negatively skewed. The overall data distribution and analysis depict a picture of students who are now comfortable of using Moodle.

5.4 The Moodle Self-Directed Learning with Technology Scale (MSDLTS) Questionnaire Statistical Analysis

The MSDLTS, on a 5-point Likert-scale, measures the respondents' perceptions in terms of their Moodle perspectives and experiences. The valid number of responses in this questionnaire was 900. The were 100 % responses with no missing values (see figure 5.71)

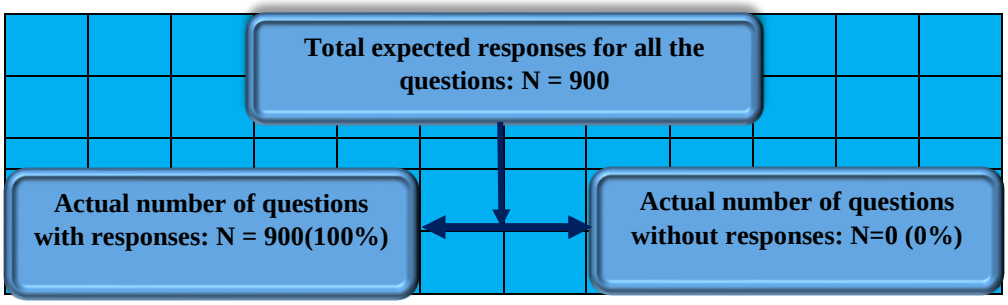


Figure 5.71: Flowchart of the Moodle Self-Directed Learning with Technology Scale (MSDLTS) questionnaire response rates

5.4.1 Moodle Self-Directed Learning with Technology Scale (MSDLTS) visual statistical data

Table 5.6 displays the Moodle Self-Directed Learning with Technology Scale (MSDLTS) visual statistical data of the respondents. This includes the number valid (N valid), number missing (N missing), mean, mode, standard deviation, and variance. The total number of students who respondents are summarised in table 5.6:

Table 5.6: The Moodle Self-Directed Learning with Technology Scale (MSDLTS) visual statistical data of the respondents

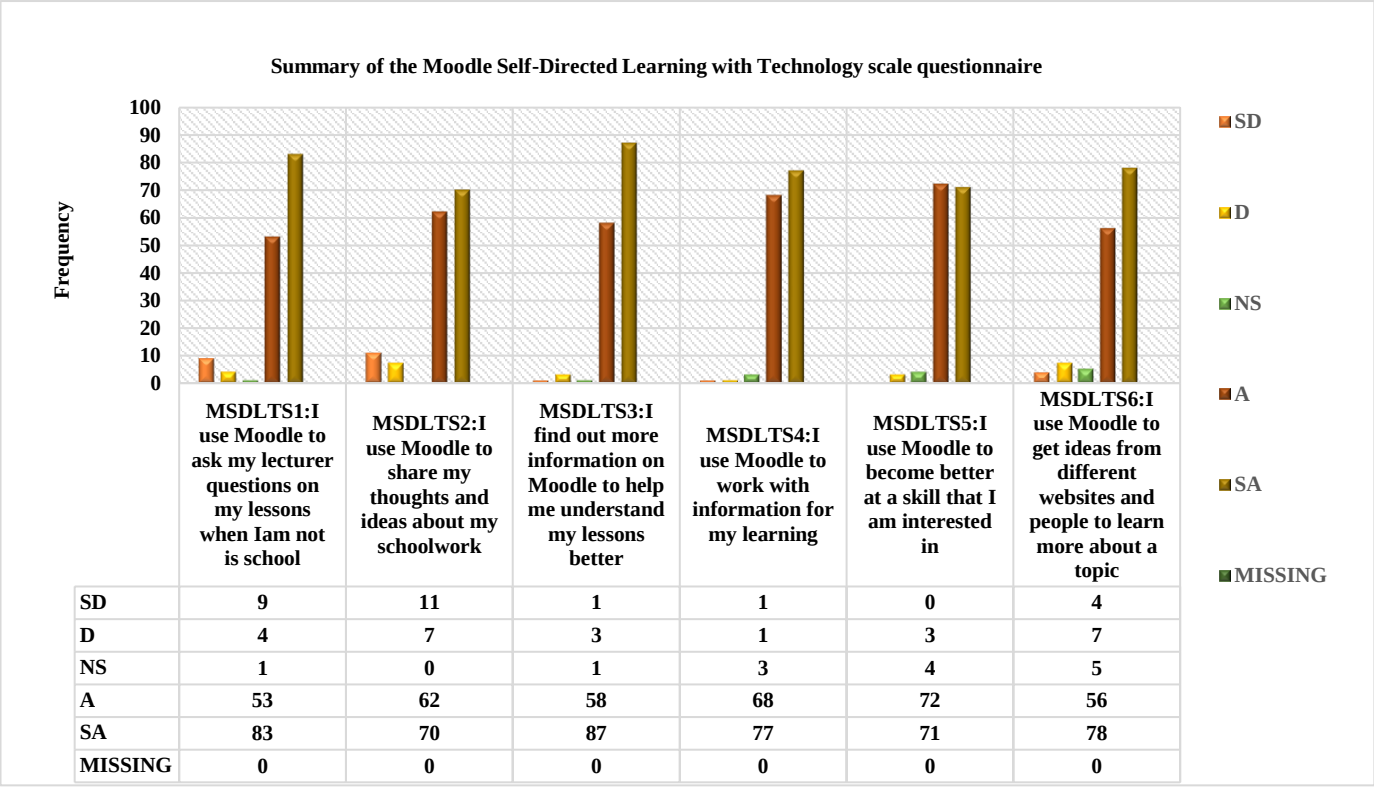
Code	Factor	N valid	N missing	Mean	Mode	Std. deviation	Variance
MSDLTS 1	I use Moodle to ask my lecturer questions on my lessons when I am not in school.	150	0	4.31	5	1.06	1.12
MSDLTS 2	I use Moodle to share my thoughts and ideas about my schoolwork.	150	0	4.15	5	1.14	1.30
MSDLTS 3	I find out more information on Moodle to help understanding my lessons better.	150	0	4.51	5	.68	.47
MSDLTS 4	I use Moodle to work with information for my learning.	150	0	4.46	5	.64	.41
MSDLTS 5	I use Moodle to become better at a skill in which I am interested.	150	0	4.41	4	.65	.42
MSDLTS 6	I use Moodle to get ideas from different websites and people to learn more about a topic.	150	0	4.31	5	.94	.89

The mean score of the participants for the whole MSDLTS is 4.36, the standard deviation is 0.85 and the variance is 0.77 and the modal score 5. The mean and the mode are closer to the highest

score on the Likert scale. The mean data analysis also shows a relative standard deviation (RSD) of 4.4 ± 19.5%. The 19.5% confirms a low relative standard deviation which means the participants' choices are closer to the mean. Accordingly, the students who completed the questionnaire show a high level of Moodle enjoyment when learning. This high level of enjoyment will have a positive impact on their self-directed learning.

Visual statistical output per question

The bar chart, Figure 5.72 as presented hereunder displays a visual statistical output of the Moodle Self-Directed Learning with Technology Scale questionnaire per question regarding the choices students made on the 5- point Likert- scale.



	MSDLTS1:I use Moodle to ask my lecturer questions on my lessons when Iam not is school	MSDLTS2:I use Moodle to share my thoughts and ideas about my schoolwork	MSDLTS3:I find out more information on Moodle to help me understand my lessons better	MSDLTS4:I use Moodle to work with information for my learning	MSDLTS5:I use Moodle to become better at a skill that I am interested in	MSDLTS6:I use Moodle to get ideas from different websites and people to learn more about a topic
SD	9	11	1	1	0	4
D	4	7	3	1	3	7
NS	1	0	1	3	4	5
A	53	62	58	68	72	56
SA	83	70	87	77	71	78
MISSING	0	0	0	0	0	0

Figure 5.72: The summary of students' responses of the Moodle Self-Directed Learning with Technology Scale questionnaire

Data as displayed in Figure 5.72 show that more than three quarter of the participants (N = 140; 93.33%) either strongly agreed or agreed that they used Moodle to ask their lecturers questions on their lessons when they were not in school, that they used Moodle to share their thoughts and ideas about their schoolwork, that they searched information on Moodle to help them understand their lessons better, that they use Moodle to work with information for their learning, and that they used Moodle to get ideas from different websites and people to learn more about a topic.

5.4.2 Findings emerging from the subscales of the questionnaire per question

Findings emerging from *Question MSDLTS1:* I use Moodle to ask my lecturer questions on my lessons when I am not in school

The bar chart (figure 5.73) provides a visual depiction of "I use Moodle to ask my lecturer questions on my lessons when I am not in school" distribution question.

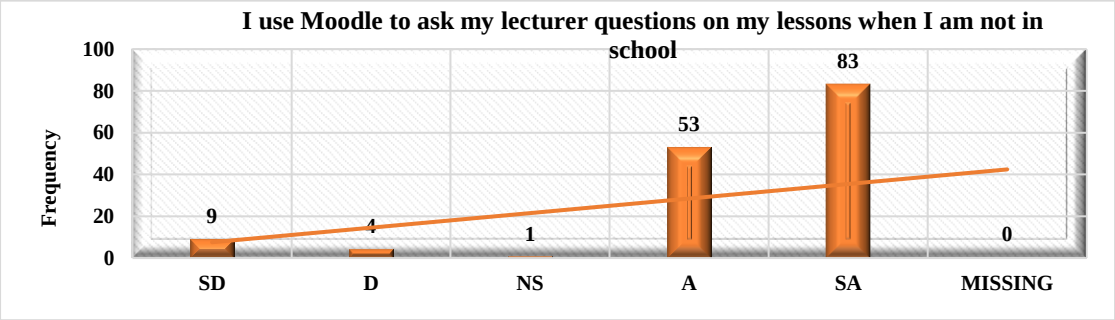


Figure 5.73: The summary of students' responses of "I use Moodle to ask my lecturer questions on my lessons when I am not in school" sub factor

This question tested the students' perceptions on whether they used Moodle to ask their lecturer lessons questions when they were not in school. The data analysis of this sub factor shows that the most frequent choice is the "SA" option (N = 83; 55.33%), followed by the "A" (N = 53; 35.33%) option. The trend line on the graph (see figure 5.73) depicts a negatively skewed data distribution with most scores falling toward the higher side of the scale. From this distribution, it can thus be deduced that most of the participants (N = 83; 90.67%), were comfortable in using Moodle to ask their lecturer questions when they were off campus.

Findings emerging from *Question MSDLTS2:* I use Moodle to share my thoughts and ideas about my schoolwork

This question assessed the students' on sharing their thoughts on Moodle platform. Moodle offers different platforms in which students may share their thoughts. The bar chart (figure 5.74) provides a visual depiction of "I use Moodle to share my thoughts and ideas about my schoolwork" distribution question.

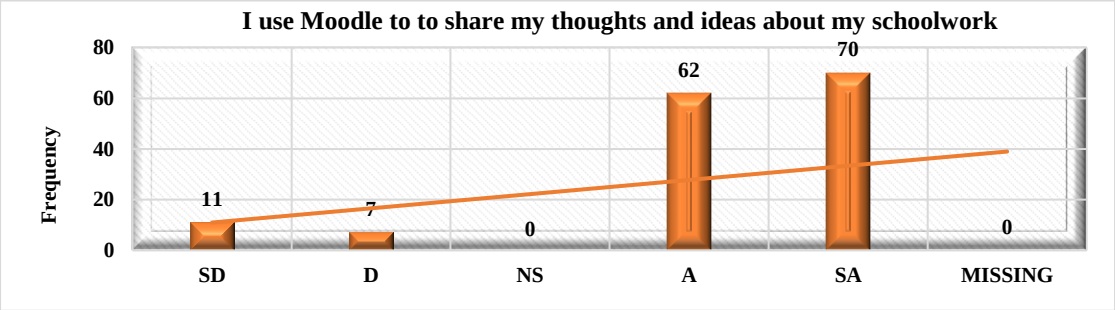


Figure 5.74: The summary of students' responses to the "I use Moodle to share my thoughts and ideas about my schoolwork" sub factor

The statistical data analysis clearly shows that the most frequent choice on the Likert scale is "SA" (N = 70; 46.67%) option, followed by "A" (N = 62, 41.33%) option. From the trendline on the graph (figure 5.74) we can clearly see that the data distribution is left skewed. What this analysis tells us is that the majority of the participants (N = 132; 88%) indicated that they shared their thoughts and ideas about their schoolwork on Moodle (SDL).

Findings emerging from Question MSDLTS3: I find out more information on Moodle to help me understand my lessons better

The bar chart (figure 5.75) provides a visual depiction of "I find out more information on Moodle to help me understand my lessons better" distribution question.

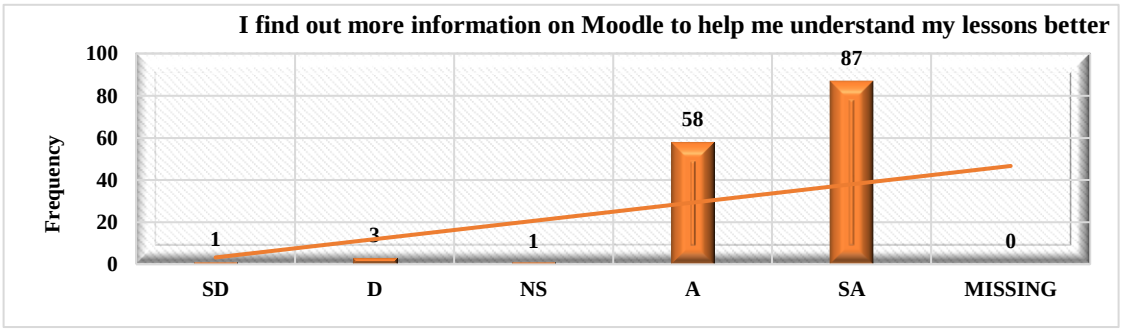


Figure 5.75: The summary of students' responses to the "I find out more information on Moodle to help me understand my lessons better" sub factor

This question assessed the students' perceptions on whether they used Moodle to find out more information to help them understand lessons better. A glance at this graph clearly shows that the most frequent choice on the Likert scale is "SA" (N = 87; 58%) option, followed by "A" (N = 58, 38.67%) option. The data distribution on the graph (see figure 5.6), clearly shows that more data fall toward the higher side of the scale. Data distribution is therefore negatively skewed. From this distribution, it can thus be deduced that most students (N = 145; 96.67%), used Moodle to find out more information to help them understand lessons better.

Findings emerging from Question MSDLTS4: I use Moodle to work with information for my learning

The bar chart (figure 5.76) provides a visual depiction of the "I use Moodle to work with information for my learning" distribution question.

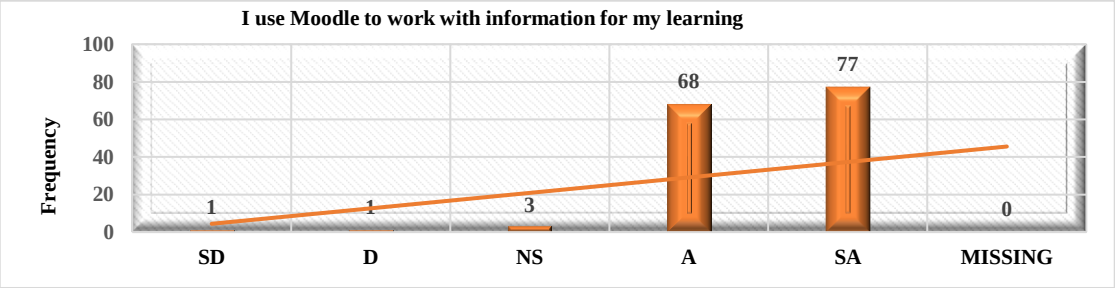


Figure 5.76: The summary of students' responses to the "I use Moodle to work with information for my learning" sub factor

The statistical data analysis on this question clearly shows that the most frequent choice on the Likert scale is "SA" (N = 77; 51.33%) option, followed by "A" (N = 68, 45.33%) option. The graph (figure 5.76) clearly displays a negatively skewed data distribution. The distribution therefore tells that most of the respondents (N = 145; 96.67%), used Moodle to work with information for their learning.

Findings emerging from Question MSDLTS5: I use Moodle to become better at a skill that I am interested in

This question assessed the students' abilities for self-directed learning focusing on the abilities to set strict time frames for engaging adequately when learning. The bar chart (figure 5.77) provides a visual depiction of "I use Moodle to become better at a skill that I am interested in" distribution question.

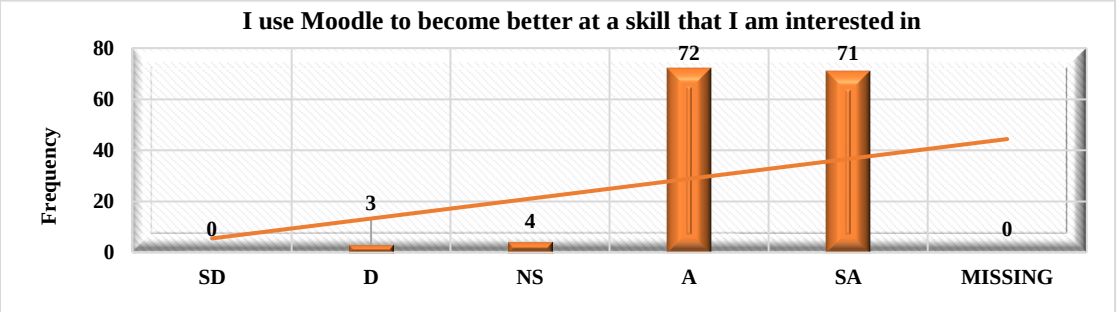


Figure 5.77: The summary of students' responses to the "*I* use Moodle to become better at a skill that I am interested in" sub factor

The data reveals that most students are now confident to search information on their own. The highest number of selection was "A" (N = 72; 48%) option, closely followed by the "SA" (N = 71; 47.33%). The trend line on the graph (see figure 5.77) shows a negatively skewed data distribution. The inference that can be made from this distribution is that the majority of the participants (N = 143; 95.33%), use Moodle to become better at a skill that they are interested in. Self-directed learning requires students to be confident in their own ability to search for information.

Findings emerging from Question MSDLTS6: I use Moodle to get ideas from different websites and people to learn more about a topic.

The bar chart (figure 5.78 provides a visual depiction of "I use Moodle to get ideas from different websites and people to learn more about a topic distribution question.

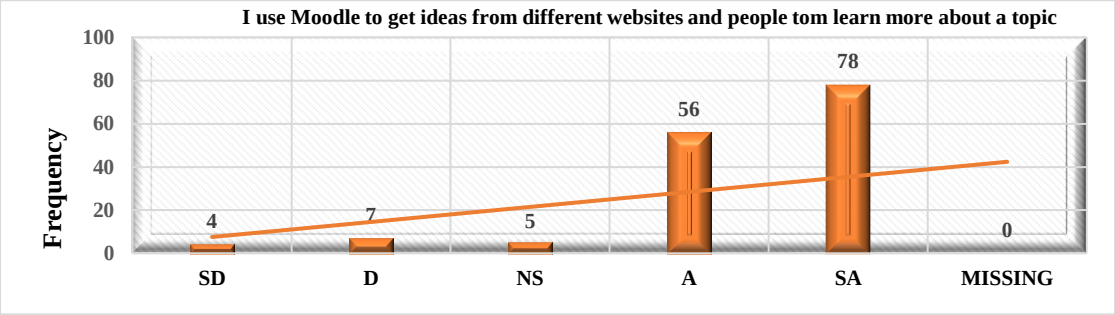


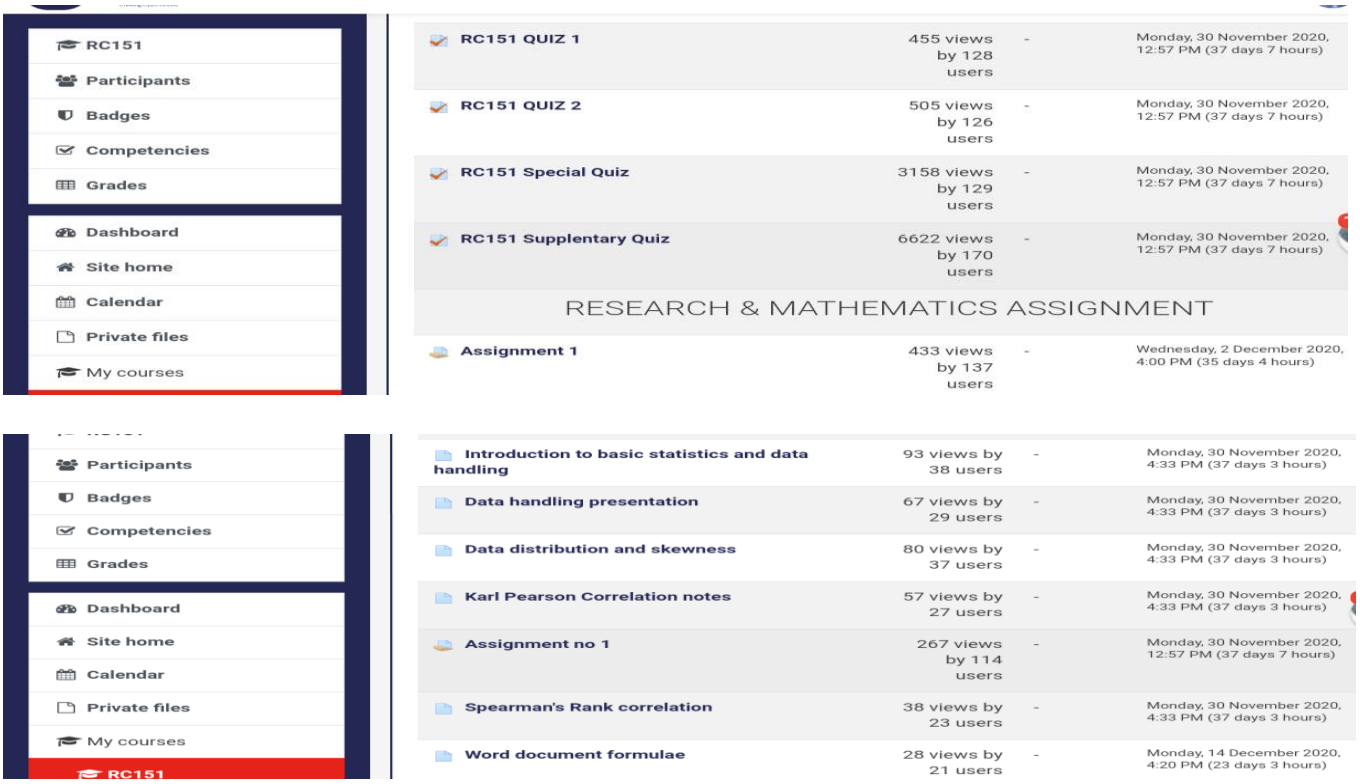
Figure 5.78: The summary of students' responses to the "I use Moodle to get ideas from different websites and people to learn more about a topic" sub factor

The statistical data analysis of this sub factor shows that the most frequent choice is "SA" (N = 78; 52%) option, followed by the "A" (N = 56; 37.33%) option. From the trendline on the graph (figure 5.78) we can clearly see that the data distribution is left skewed. Most scores fall towards the higher side of the scale. The inference that can be made from this distribution is that more than three quarter of the participants (N = 134;89.33%) use Moodle to get ideas from different websites and people to learn more about a topic.

This section presented quantitative data from the post evaluation questionnaires. It, therefore, data about students' Moodle experience and self-directed learning readiness. The data analysis indicates that most students (N = 134; 89.33%), now have Moodle nor internet experience. Data analysis also shows that most students' self-directed readiness is high. Full discussion of the data analysis will be done in chapter 6. In the next section, the findings of action log analysis are presented.

5.5 Action login analysis

This section presents data analysis conducted on the Moodle server logins of the students. The action logins provided an insight of the use of Moodle in students' learning for self-directed learning. The log entries represent evidence of the behaviour which the students exhibited when logged into the Moodle. These logins were obtained from the Moodle platform website itself and highlighted the actions taken by the participants over time when logged into the platform. The data were downloaded as files in Microsoft excel (.xlsx). The total number of each activity log and its average was calculated. By doing this, the researcher was analysing students' online Moodle behaviour for self-directed learning. An example of activity login is displayed in the figure 5.79:



Component	Event name	Description	Origin
Assignment	The status of the submission has been viewe	The user with id '6091' has viewed the submission status page for the assignment with course module id	ws
Forum	Discussion	The user with id '4409' has viewed the discussion with id '2912' in the forum with course module id '150'.	web
File	Course module viewed	The user with id '3537' viewed the 'resource' activity with course module id '20653'.	ws
Forum	Course module viewed	The user with id '4409' viewed the 'forum' activity with course module id '150'.	web
Overview report	Grade overview report viewed	The user with id '3220' viewed the overview report in the gradebook.	web
System	User profile viewed	The user with id '3107' viewed the profile for the user with id '49' in the course with id '40'.	web
User report	Grade user report viewed	The user with id '3529' viewed the user report in the gradebook.	web
Forum	Discussion viewed	The user with id '4044' has viewed the discussion with id '2911' in the forum with course module id '150'.	ws
Assignment	Feedback viewed	The user with id '4989' viewed the feedback for the user with id '4989' for the assignment with course mc	web
Quiz	Course module viewed	The user with id '6176' viewed the 'quiz' activity with course module id '37381'.	ws
Quiz	Quiz attempt viewed	The user with id '4893' has viewed the attempt with id '145602' belonging to the user with id '4893' for the	web
Quiz	Quiz attempt submitted	The user with id '6157' has submitted the attempt with id '145308' for the quiz with course module id '376	ws

Figure 5.79: The Screencapture of students Moodle logins

Table 5.7: Total number of students' Moodle logins

Course/Activity logs	Number of students	Total number of action logs	Average actions per student
Online Assignment	150	22 500	150.00
Online Quiz	150	22 500	150.00
Questions posted	150	4 956	33.04
Discussion Forums	150	18 487	123.25

Table 5.7 unequivocally demonstrates how involved the students were in utilizing Moodle as an LMS for self-directed learning. All participants completed successfully their online assignment and quiz. While 123 students participated in discussion forums, 33 students on average posted questions on Moodle. So, it can be seen from these activity logs that students used Moodle to improve their self-directed learning.

The important thing about these actions is that they were utilized to represent the many kinds of activities that students engaged in when logged into Moodle together. The fundamental presumption made here is that students' behaviours reveal intentionality, which in turn reveals information about their preferred learning styles and self-directed learning. Therefore, the actions assisted in determining if Moodle encourages self-directed learning in mathematics. The activity logins showed that there was student collaboration.

5.6 Qualitative Data Analysis: Interviews

This section presents the qualitative data obtained from the in-depth semi-structured interviews. The primary purpose was to obtain insight to the students' experiences and perspectives on mathematics self-directed learning. The researcher conducted semi-structured interviews with a total of five students. The interviews were recorded, transcribed, and then analyzed. The researcher sought to find themes in the data while organizing and analyzing the qualitative data. Throughout the analysis, themes were identified and redefined several times. To start the process of choosing representative codes for the presentation of data, the transcribed data were read again, with the major concepts highlighted. The researcher employed an inductive, theory-generating strategy to analyze qualitative data. Open, axial, and selective coding were the three ideal-typical steps that the study took.

5.6.1 Open Codes

The researcher began by reading through all of the transcribed verbatim. The researcher approached the transcribed data in the first, inductive phase of open coding with an open mentality in order to ascertain what concepts the data revealed. The researcher coded the data as he read it by circling key concepts and highlighting major sentences. The analysis was open and focused since the researcher took the research questions into account when choosing the data ideas that related to the study's objective.

SDL was the main focus of this study, hence all terms and phrases associated with it were coded. These codes were derived from the respondents' expressions. The researcher stayed very close to the interview transcripts during this open coding process, and this coding process produced a wide variety of codes. The cross-comparison and adjoining of codes revealed several commonalities and differences. Open coding resulted in the development of codes (labels) that were thought to be appropriate for the representation of the gathered data. The open coding stage resulted in the establishment of a total of 22 codes. Table 5.8 lists some of these codes together with the sentences they correspond to.

Table 5.8: Students' statements and their associated open codes.

Students' statements	Open codes
Moodle encouraged me to be open-minded, to think outside the box. Moodle encouraged me to question constantly and inquire online if there is something I do not understand.	Inquisitive
What I like about Moodle is that it offers us an opportunity of sharing knowledge.	Knowledge sharing
The way the teacher has set the module is easy, practical, and efficient. It is easy to navigate around the Moodle platform. Moodle class had taught me the importance of planning to complete a task or solve a problem successfully: "Without Moodle I used to just do things without first thinking about that".	Planning
Moodle increases problem solving skills. It helps us to be critical thinkers. This is because Moodle encompasses problem solving lessons.	Problem solving
Moodle online learning helped me to understand what I am learning more deeply.	Deeper understanding
I interact with other students using chat room/discussion. If I feel embarrassed to ask on a discussion board, I can directly ask the teacher or other friends through the chat session. Chat sessions are helpful because they stimulate me to ask questions.	Learning through chats
I have shared experiences with my fellow students on Moodle forum.	Learning through forums
With Moodle I can stay connected academically and socially. I can reach out to both the lecturer and other students when they are having difficulty or a question.	Communication
Moodle helped me to be active in seeking out information and assistance from my fellow students, as opposed to waiting for direction from the lecturer. If I wanted information on a topic or had a question and wanted quick answers, I mostly use a community discussion platform. This allowed me to look at questions others asked about a topic I also had a question about.	Cooperative learning
Moodle has made me to be more enthusiastic to learn mathematics. It has made me to become more active in learning and not just to depend on the lecturer. What I like about Moodle is that I am now able to work independently. I prefer the Moodle online class. It is like being on your own, working at your own pace, but like do-it-yourself.	Independent learning
Moodle enables me to learn without being constrained by time and space.	Time management
Moodle is good because most of the assessment is done online. Online quizzes helped me to learn effectively.	Assessment
I like Moodle because feedback is mostly delivered online.	Feedback
I like completing Moodle quizzes. This is because I mostly got immediate feedback. This motivates me to study harder and perform better in tests.	Self-motivation
I enjoy learning through Moodle because its design is more user friendly. I like to do Moodle online discussions because I can ask questions about materials that I have not understood directly without having to wait for mathematics learning in the class.	Enjoyment
I am able to help others if they need help and assist them to complete any task if needed, also illustrating how their confidence had grown in the class.	Support
Moodle helps me to monitor my own learning in terms of prescribed module and also to modify one's practices if necessary.	Self-monitoring
I developed a sense of autonomy in the learning process. We are given mathematics module outlines and other materials by the lecturer. I am able to go through the whole module outlined on my own and be able to complete tasks independently.	Self-management
My learning is now flexible. I can do my tasks at my own pace, place, and time.	Self-control
The lecturer upload questions asking us to reflect on the lesson.	Self-reflection
With Moodle learning, I have learnt to evaluate my own work. I recheck the problem and evaluate the problem and solution.	Self-evaluation
My confidence in learning mathematics has increased. Moodle has helped me to improve my self-esteem when I am communicating with others.	Self-belief
Moodle increases my sense of responsibility.	Personal responsibility

5.6.2 Axial codes

Upon the completion of the open coding stage, axial coding was employed to identify emerging core categories. Charmaz (2016, p. 138) conceptualise axial coding as "the process of relating codes to each other into categories". The basic framework of the relationship was based on the phenomenon under study which was self-directed learning. Through constant comparison of the codes, the researcher identified six axial codes which formed the categories of this data: positive dispositions, cognition/metacognition, problem solving, social learning, flexible learning, instant feedback, active learning, sense of self, self-belief, and personal responsibility. Table 5.9 display how the interview data was coded into open codes, and then to axial coding.

Table 5.9: Students' statements and their associated open and axial codes

Students' statements.	Open codes	Axial codes: Categories
Moodle encouraged me to be open-minded, to think outside the box. Moodle encouraged me to question constantly and inquire online if there is something I do not understand.	Inquisitive	**Positive dispositions**
What I like about Moodle is that it offers us an opportunity of sharing knowledge.	Knowledge sharing	
The way the teacher has set the module is easy, practical, and efficient. It easy to navigate around the Moodle platform. Moodle class had taught me the importance of planning to complete a task or solve a problem successfully: "Without Moodle I used to just do things without first thinking about that.	Planning	**Cognition/ metacognition**
Moodle increases problem solving skills. It helps us to be critical thinkers. This is because Moodle encompasses problem solving lessons.	Problem solving	**Problem solving**
Moodle online learning helped me to understand what I am learning more deeply.	Deeper understanding	
I interact with other students using chat room/discussion. If I feel embarrassed to ask on a discussion board can directly ask the teacher or other friends through the chat session. Chat sessions are helpful because they stimulate me to ask questions.	Learning through chats	**Social learning**
I have shared experiences with my fellow students on Moodle forum.	Learning through forums	
With Moodle I can stay connected academically and socially. I can reach out to both the lecturer and other students when they were having difficulty or a question.	Communication	
Moodle helped me to be active in seeking out information and assistance from my fellow students, as opposed to waiting for direction from the lecturer. If I wanted information on a topic or had a question and wanted quick answers, I mostly use a community discussion platform. This allowed me to look at questions others asked about a topic I also had a question about.	Cooperative learning	
Moodle has made me to be more enthusiastic to learn the mathematics. It has made me to become more active in learning and do not just depend on the lecturer. What I like about Moodle is that I am now able work independently. I preferred the Moodle online class. It was like on your own, not at your own pace, but like do-it-yourself.	Independent learning	**Flexible learning**
Moodle enables me to learn without being constrained by time and space.	Time management	
Moodle is good because most of the assessment is done online. Online quizzes helped me to learn effectively.	Assessment	**Instant feedback**
I like Moodle because feedback mostly delivered online.	Feedback	
I liked completing Moodle quizzes. This is because I mostly got immediate feedback. This motivated me to study harder and perform better in tests.	Self-motivation	
I enjoy learning through Moodle because its design is more user friendly. I like to do Moodle online discussions because I can ask questions about materials that I have not understood directly without having to wait for mathematics learning in the class.	Enjoyment	**Active learning**
I was able to help others if they had to and that they themselves were able to complete any task if needed, illustrating how their confidence had grown in the class.	Support	
Moodle helped me to monitor my own learning in terms of prescribed module of the need to modify one's practices if necessary.	Self-monitoring	**Sense of self**
I developed a sense of autonomy in the learning process. We are given mathematics module outlines and other materials by the lecturer. I am able to go through the whole module outlined on my own and be able to complete tasks independently.	Self-management	
My learning is now flexible. I can do my tasks at my own pace, place, and time.	Self-control	
The lecturer upload questions asking us to reflect on the lesson.	Self-reflection	
With Moodle learning, I have learnt to evaluate my own work. I recheck the problem and evaluate the problem and solution.	Self-evaluation	
My confidence in learning mathematics has increased. Moodle has helped me to improve my self-esteem when I am communicating with others.	Self-belief	**Self-belief and personal responsibility**
Moodle increases my sense of responsibility.	Personal responsibility	

5.6.3 Theoretical (Selective) Codes

Following the completion of axial coding, the researcher used theoretical (selective) coding to identify the major themes in the transcribed data. The final stage of coding, theoretical coding, allows for the saturation of the core categories identified during axial coding while open coding and axial coding made it easier to organize the codes and concepts generated during the open coding stage into higher level categories. The use of memos (containing reflections on the

concepts and categories) and constant comparison between axial codes were instrumental for theoretical coding. The analysis evolved from a straightforward description to conceptualization during each of these steps of refinement and saturation. The following themes—Cognitive Moodle SDL, Behavioural Moodle SDL, Affective Moodle SDL, and Self-efficacy Moodle SDL—emerged within the fractured categories (see table 5.10).

Table 5.10: Students' statements and their associated open, axial codes and theoretical codes (themes)

Students' statements	Open codes	Axial codes: Categories	Themes
Moodle encouraged me to be open-minded, to think outside the box. Moodle encouraged me to question constantly and inquire online if there is something I do not understand.	Inquisitive	**Positive dispositions**	Cognitive Moodle SDL
What I mlike about Moodle is that it offers us an opportunity of sharing knowledge.	Knowledge sharing		
The way the teacher has set the module is easy, practical, and efficient. It easy to navigate around the Moodle platform. Moodle class had taught me the importance of planning to complete a task or solve a problem successfully: "Without Moodle I used to just do things without first thinking about that.	Planning	**Cognition/ metacognition**	
Moodle increases problem solving skills. It helps us to be critical thinkers. This is because Moodle encompasses problem solving lessons.	Problem solving	**Problem solving**	
Moodle online learning helped me to understand what I am learning more deeply.	Deeper understanding		
I interact with other students using chat room/discussion. If I feel embarrassed to ask on a discussion board can directly ask the teacher or other friends through the chat session. Chat sessions are helpful because they stimulate me to ask questions.	Learning through chats	**Social learning**	Behavioural Moodle SDL
I have shared experiences with my fellow students on Moodle forum.	Learning through forums		
With Moodle I can stay connected academically and socially. I can reach out to both the lecturer and other students when they were having difficulty or a question.	Communication		
Moodle helped me to be active in seeking out information and assistance from my fellow students, as opposed to waiting for direction from the lecturer. If I wanted information on a topic or had a question and wanted quick answers, I mostly use a community discussion platform. This allowed me to look at questions others asked about a topic I also had a question about.	Cooperative learning		
Moodle has made me to be more enthusiastic to learn mathematics. It has made me become more active in learning and do not just depend on the lecturer. What I like about Moodle is that I am now able work independently. I preferred the Moodle online class. It was like on your own, not at your own pace, but like do-it-yourself.	Independent learning	**Flexible learning**	
Moodle enables me to learn without being constrained by time and space.	Time management		
Moodle is good because most of the assessment is done online. Online quizzes helped me to learn effectively.	Assessment	**Instant feedback**	
I like Moodle because feedback mostly delivered online.	Feedback		
I liked completing Moodle quizzes. This is because I mostly got immediate feedback. This motivated me to study harder and perform better in tests.	Self-motivation	**Active learning**	Affective Moodle SDL
I enjoy learning through Moodle because its design is more user friendly. I like to do Moodle online discussions because I can ask questions about materials that I have not understood directly without having to wait for mathematics learning in the class.	Enjoyment		
I was able to help others if they had to and that they themselves were able to complete any task if needed, illustrating how their confidence had grown in the class.	Support		
Moodle helped me to monitor my own learning in terms of prescribed module of the need to modify one's practices if necessary.	Self-monitoring	**Sense of self**	
I developed a sense of autonomy in the learning process. We are given mathematics module outlines and other materials by the lecturer. I am able to go through the whole module outlined on my own and be able to complete tasks independently.	Self-management		
My learning is now flexible. I can do my tasks at my own pace, place, and time.	Self-control		
The lecturer upload questions asking us to reflect on the lesson.	Self-reflection		
With Moodle learning, I have learnt to evaluate my own work. I recheck the problem and evaluate the problem and solution.	Self-evaluation		
My confidence in learning mathematics has increased. Moodle has helped me to improve my self-esteem when I am communicating with others.	Self-belief	**Self-belief and personal responsibility**	Self-efficacy Moodle SDL
Moodle increases my sense of responsibility.	Personal responsibility		

These themes represent the overarching concepts discussed by research participants. Although the concepts connected to each core theme were not always the same as those reported by all participants, iterative conceptualization showed that these major themes contained the participants' main perspectives regarding Moodle mathematics Self-directed learning. Chapter 6 provides a thorough discussion of these themes. Furthermore, the relationships among these four themes are elaborated. These themes led to the development of a learning theory, the Moodle Mathematics Self-Directed Learning theory. This learning theory is also exhaustively discussed in chapter 6.

The data collected from the interviews were analysed to get more insight on the quantitative findings of the study.

5.7 Chapter conclusion

In this chapter, data from the quantitative and qualitative aspects of this study have been presented. This has involved the presentation of three sets of data obtained from questionnaires, Moodle logs and interviews. Quantitative data from the participants' questionnaires were first presented followed by quantitative data from participants' Moodle log ins. These were followed by the qualitative data in the form of participants' views as expressed through interviews. Data analysis helped to identify patterns and emerging themes from students' responses regarding their perspectives on Moodle mathematics self-directed learning. The process of analysing interview data revealed some key themes which were then used to organise and present the data. Four common themes featured in all the three sets of interview data, namely: Cognitive Moodle SDL, Behavioural Moodle SDL, Affective Moodle SDL, and Self-efficacy Moodle SDL

The results of the descriptive and qualitative analysis have been tabulated, graphically and thematically presented. In the next chapter, both the quantitative and qualitative data presented in this chapter will be discussed.

CHAPTER 6: DISCUSSION AND PRESENTATION OF THE FINDINGS

6.1 Introduction

The previous chapter was focused on eliciting answers to accomplish the objectives of the study. In Chapter 5, a report of the findings and results analysis that were produced statistically in accordance with the research paradigm, in order to meet the research objective, were specifically presented. This chapter expands on the report as it is presented in chapter 5 by discussing the findings of the research process in the context of the objective that had been established to address the study's research questions and aims. Hence, the purpose of this chapter is to summarize the findings following data analysis. This chapter also discusses the conclusions that can be drawn from the empirical study as well as the amount of scholarly literature that was consulted. This chapter therefore presents the summary of this study and presents the implications of the findings based on the data that were presented in Chapter 5. It also gives the researcher a chance to interpret, describe, and recommend further research based on the findings.

6.2 Discussion and presentation of the findings

In this section, the results are presented based on this study's research questions. The main research question that the study addresses is: What relationship exists between Moodle Learning Management system and students' self-directed learning. The four sub-research research questions that the study addresses are: How do students use Moodle Learning Management system for self-directed learning? To what extent do students perceive themselves to have the necessary skills to use Moodle for mathematics self-directed learning? After using Moodle, how do students perceive the improvement of their Mathematics self-directed skills? How do students perceive the usefulness, effectiveness, and ease of use of Moodle?

6.2.1 The research questions

Main research question: What relationship exists between Moodle Learning Management system and students' self-directed learning?

Data from study indicate that students view Moodle as an LMS that fosters the development of their learning autonomy. This finding is congruent with what Subashkevych, *et al.* (2021) found in their investigation. In their study Subashkevych, *et al.* (2021) found that the use of Moodle is useful in encouraging learner autonomy as well as in facilitating cooperation and learner-centered learning environments. Self-directed learning and autonomy are related to one another. Self-directed learning aims to support students' development of learning autonomy. Autonomous

learners are those that can complete tasks on their own, without assistance from others. These students are in charge of their own learning.

The findings of this study also show that Moodle is an LMS that improved the students' learning independence. Independent learning is therefore also linked to self-directed learning. When an individual can think, act, and pursue his/her own studies independently without the same levels of support that one receives from a teacher at school, he or she is said to be engaged in independent learning. Students are encouraged to pursue autonomous learning and develop independence through the usage of Moodle. Students were able to log in at their own time and learn at our own pace.

Research data also show that Moodle enhances personal goal setting. Self-directed learning is a method of learning when students take the initiative to create their own learning objectives. Students can determine for themselves how much content they want to cover each week based on the Module's outline's contents.

Sub-research question 1: How do students use Moodle learning management system for self-directed learning

Based on the analysis of the research data, students used Moodle to coordinate the submission of their work. Students were able to submit their work and get the lecturer's comments and grades. The Moodle system enables lecturers to grade assignments and allows students to post assignments for evaluation.

Students were able to interact, communicate and work together with their peers using Moodle's course forums. Moodle's chat feature enabled communication via online messaging. As a result, students were able to discuss topics, exchange ideas, and even offer critiques on one another's work. The results agree with the study of Aikina and Bolsunovskaya (2020) who confirmed that:

> …the Moodle system provides interactivity between lecturers and students, and between students themselves by using interactive tools to facilitate the good communication such as chats and forums. Collaboration and communication had a positive impact on students’ online social learning.

Students were able to track and monitor their progress and reports using Moodle. The results of any graded activities are saved in Moodle for each student. Students were able to view snapshot reports at any moment they were doing with the course materials. A thorough audit trail is also there to track the frequency and timing of students' resource access.

The fact that Moodle includes an automated assessment was also advantageous to the students. Students have the chance to assess themselves through the quiz activity and receive quick feedback on their responses. This gave students the chance to periodically assess themselves, which helped them gain knowledge and confidence as they progressed through their learning process.

Regarding Moodle's purpose of use, the main primary function of Moodle was to download materials, monitor course announcements and updates, submit assignments, ask questions, and chat with other students and instructors. These findings suggest that Moodle is mostly used as a library of resources and data.

Sub-research question 2: To what extent do students perceive themselves to have the necessary skills to use Moodle for self-directed learning?

The results showed that students believed Moodle had the abilities needed to be used for self-directed learning. They said they can independently locate course information, complete course assignments, obtain course materials, and plan their studies. This is self-directed learning. These findings correspond with those of Chang and Lan (2021) whose investigation revealed that Moodle enhances students' capacity for self-directed learning.

Data from the study also reveal that Moodle also improved their Motivation to learn. According to Akbar, Claramita, and Kristina (2017), academic motivation is:

> …an important factor influencing SDL. In this study, the students stated that the Moodle e-learning system motivated them to learn independently since it supported quick online submission of assignments.

The research findings from the study by Adib, Ghiyasvandian, Varaei, and Roushan (2019, p. 8) revealed "a correlation between academic motivation and SDL in multiple experiments and discovered that a student's intrinsic motivation was a major factor in deciding whether they achieved a passing or failing grade". These students who put their own motivation for learning first are more eager to progress at their own pace.

Sub-research question 3: After using Moodle, how do students perceive the improvement of their self-directed skills?

The results of this study show that Moodle improved self-directed learning since most students had to access content outside of the classroom. The students' motivation and willingness to learn independently increased as a result of the necessity to access these learning resources. Students

were able to access course materials at any convenient time and from any convenient location because of Moodle's flexibility. Students indicated that they were now able to manage and engage the uploaded content on their own.

The way that students learn to collaborate and communicate with their peers has also improved. Students used the course forums to discuss subjects, exchange ideas, and even give each other feedback on their work. Also, they made use of Moodle's chat feature, which enables pre-arranged messaging online.

The study's findings also showed that the students independently used the Moodle system for a variety of tasks, including completing assignments, checking the schedule of events, downloading course materials, and engaging in conversation with their lecturers.

Sub-research question 3: How do students perceive the usefulness, effectiveness, and ease of use of Moodle?

According to research by Al-Fraihat, Joy, Masa'deh, and Sinclair (2020, p. 74), "perceived usefulness and perceived ease of use are important predictors of students' satisfaction with e-learning". Students said Moodle was user-friendly in terms of perceived usefulness and ease of use. This is due to Moodle's ability to speed up informational delivery. The majority of students strongly agree that Moodle is simple to use, gives them access to the course materials, and is very practical and user-friendly. As far as logging in, navigating, submitting assignments, accessing course materials, downloading documents and files, and taking online quizzes and tests, the students said Moodle was simple to use. This assessment of Moodle's usability is consistent with the findings of a study by Yildiz, *et al.* (2018), which claimed that one benefit of Moodle is that it is user-friendly.

According to the research findings, students thought the Moodle interface was simple to use and intuitive. Online or distant learning is made possible via Moodle. Learning resources were available to students around-the-clock. The students had access to learning resources anytime they needed them. Much easier access via a smartphone or other mobile device is made possible via a mobile app.

Study findings also revealed a component of Moodle perceived satisfaction. The Moodle system, its operations (uploading or downloading), effectiveness, and efficiency all received positive feedback from the students. The findings concur with the study by Chang and Lan (2021), which found that students' feedback about the Moodle system's usefulness and efficiency increased their

satisfaction with it. The results of the study demonstrate that students thought Moodle was practical, efficient, and simple to use because it made it simple for them to control how their work was submitted. The lecturer provided feedback and grades after students submitted their work.

The students concurred that the Moodle LMS lessened their workload because the tasks were distributed in advance, giving them the chance to distribute the work more evenly and manage their time more effectively. The findings of this study support the hypothesis that the impression of the Moodle platform as being simple to learn or use influences users' intentions to use it.

The findings from this research in regard to the usefulness, effectiveness, and ease use of Moodle appear to be consistent with those of earlier studies. For instance, research by Acar and Kayaoglu (2020), as well as Murillo, Novoa-Hernandez, and Rodrguez (2020), indicated that the usage of Moodle enhanced students' learning and that they had a favorable perception of utilizing Moodle in online classes. The study by Al-Samarraie, Teng, Alzahrani, and Alalwan (2017, p. 13) also found that "perceived usefulness significantly influences students' satisfaction. The conclusion is that students tend to be more satisfied with a system when they think it is easy to use and gives them useful information".

6.2.2 The themes that emerged from this study.

There are four themes that emerged from this study, namely the Cognitive Moodle SDL theme, the Behavioural Moodle SDL theme, the Affective Moodle SDL theme, and the Self-efficacy Moodle SDL theme. These themes can be understood in light of how universities teach students with the intention of encouraging self-directed learning. If the aim for transforming online self-directed learning in higher education is to be successful, the themes that emerged from the research are essential constructs of quality. These themes are discussed in the subsequent subsections.

6.2.2.1 Theme 1: Moodle SDL cognitive theme.

This theme focuses on the cognitive skills that students develop while using Moodle to learn. The adjective cognitive comes from the Latin word "cognoscere" meaning "to get to know". According to Pagán (2018), cognition is the mental process involved in knowing, understanding, and having the ability to learn new information. Hence, it has to do with the brain's capacity for thought, reasoning, and problem-solvingCognition is an intellectual process by which information is obtained from perception or ideas, according to Pentaraki and Burkholder (2017).

The codes that emerged from this study associated with this theme are Inquisitive, Knowledge construction, Creative, Planning, Reasoning, Problem solving, Deeper understanding (see table 5.8). In this study the categories associated with this theme are Moodle encourages positive dispositions, Moodle encourages cognition/metacognition, Moodle problem solving (see table 5.8)

According to this study, Moodle's online instruction and learning enabled students to comprehend the study materials more fully. This study showed that Moodle improved students' problem-solving abilities. They were able to think critically because of Moodle's inclusion of problem-solving lessons. Aspects of critical thinking were discovered through student interviews and narratives. According to the students, Moodle increased their creativity and curiosity. For instance, S1 said that Moodle "helps us to be good in thinking and creating something and also to think creatively."

Students claim that Moodle provides a platform for and promotes cognition and metacognition. During the interviews with the students, decision-making, analysis, logic, reasoning, thinking, and thinking were identified as cognitive abilities.

This study's findings showed that Moodle promotes positive dispositions open-minded. For example, S2 commented that “Moodle lessons forces you to think outside the box”. Moodle, according to students, fosters curiosity and creativity, which supports self-directed learning. Students thought Moodle encourages positive dispositions well. The dispositions identified were; (i) creativity: “Moodle helps me to be creative and informed so that I can be a great thinker to think very fast” (S1); (ii) inquisitiveness: “I am a person who likes to know answers for the questions” (S2); (iii) interest: (S3); and (iv) questioning (the disposition mostly quoted): Moodle boosted their propensity for asking questions and provided them with opportunities to do so.

The study concluded that Moodle gave students the confidence to be more independent and open-minded. Students with more advanced self-regulatory cognitive skills are more likely to be academically motivated and learn more than other students, according to D'Errico, Paciello, and Cerniglia (2016).

6.2.2.2 Theme 2: Moodle SDL behavioural theme.

The SDL behavioural theme focuses on the behaviours associated with online learning in a network setting. It has to do with students' characteristics based on an analysis of their online learning behaviour and their self-controlled behaviour. According to Yusuf *et al*., (2021), this behaviour is:

> manifested in online personality trait of self-determination, which is the ability to regulate and adapt behaviour to the demands of a situation to achieve personally chosen goals and values.

The codes associated with this theme in this study are Learning through chats, Learning through forums, Cooperative learning, Independent learning, Extra activities, Time management, Assessment and Feedback. In this study, this theme is associated with categories like Moodle encourages social learning and Moodle promotes learning flexibility, Moodle provides instant feedback.

This study revealed that students believe Moodle tasks are created to bring out the best in them (Mean=4.18, SD=.693). Students feel that Moodle gives them the chance to demonstrate their grasp of lessons through assigned tasks. Students claim that Moodle online learning has several advantages because they are not constrained by time or location. The following student response during the interview demonstrates this outcome: “Moodle learning helps me learn more than I used to learn in the classroom because I can study anywhere”; “The tasks given in Moodle online learning are quite a lot but also stimulate me to learn more”. Students use the online discussion tools to ask questions or seek clarification on content they have not grasped.

Also, this study discovered that Moodle classes encouraged students to assess their own work. They consistently receive online feedback on all of the mathematics assignments they are given, which contributes to this. Some students had superior learning opportunities because they were able to get comments and subsequently change their work in response. Autonomy in the learning process is also encouraged by letting students evaluate their own work on Moodle. Autonomy is the capacity to take command of one's education, recognize options, and manage choices through constant introspection and assessment. When a student has autonomy in their education, that means they are in charge of making decisions that will affect their learning and carrying those decisions out. Students can take charge of their own learning because of their independence. Autonomous learners are capable collaborators in the learning process who contribute to deciding what to learn, how to learn it, and how quickly to learn it. By adapting the material, style, and

pace of instruction to each student's individual needs, lecturers can help them learn the same concepts as their peers in ways that are best suited to their aptitude and drive. Students who experience student autonomy grow in their feeling of accountability and drive.

This study showed that the use of Moodle enhanced students' sense of accountability, which in turn boosted their online SDL behaviour. SDL relates to the capacity for independent work. Students expressed a wish to work independently and in their own spaces. They also liked working at their own pace and in the setting of their choice rather than attending class during set times. This area just so happened to be on campus. One of the students' comments that supported this claim is: "I preferred the Moodle online class. It was like on your own, not at your own pace, but like do-it-yourself" (S3). This student spoke about preferring the flexible format and expressed his desire to be taught through Moodle.

Students also talked about the benefits of independently accessing uploaded resources at any time. These resources are available to students through the university's learning management system. Before the real lesson begins, they can access all the material there. For example, S1 stated that: "Everything was available to me before the lessons started. This gives me an opportunity to download all the relevant study materials, and this places me to be in a better position to understand the lesson when it starts". This encourages self-directed learning as it encourages students to take the initiative of seeking out information for themselves.

Through the discussion board forums, students were able to pick up study tips from one another. Sharing her experience with the discussion board, S1 described the forums and chats as a way to create conversations based around the content area, with a focus on sharing one's own point of view compared to what other students had shared. She remarked that "We are all posting and reading each other's posts and then we are creating conversations based around the questions. We would get questions, ponder them, write out our answers, and then respond to two other people's answers."

Also, the study found that Moodle gives students the willingness, desire, and drive to search for knowledge and ask for help. S4 claimed that rather than waiting for guidance from the lecturer, he actively sought out information and support in the online environment. Throughout the duration of the course, students' discussions went beyond merely collecting course information and materials to include various sorts of instructors and other support contacts. Students talked about having the awareness to recognize when they needed to reach out, being persistent in doing so, and realizing that it was their duty to do so. Others discussed the advantages of asking for help.

According to S4 “If I wanted information on a topic or had a question and wanted quick answers, I would use a community discussion platform. This allowed me to look at questions others asked about a topic I also had a question about”.

The study also found that Moodle is used as a tool for constant communication. Students emphasized that effective communication is essential for success in the online environment. They commonly mentioned their capacity for starting and continuing conversations as well as their willingness to do so in a variety of settings, the majority of which were online. As they encountered difficulties with their online learning, they discussed how they had to get in touch with both the lecturer and other students. This study therefore established that students are satisfied with Moodle teaching and learning because they can interact with other students using chat room and forums (Mean=4.28, SD=.634). Students mentioned using Moodle to stay on top of their academic work, but they all focused more on how much easier it was to maintain social connections.

Students identified organization and time management, communication as crucial factors for success in the SDL learning. Organization and time management were cited by students as being essential to success in the Moodle online environment. The flexibility of the online class structure and the students' ability to manage their time were the two primary factors that helped them stay organized. Flexibility was related to working wherever and whenever. Working "anytime, anywhere" was cited by students as a benefit of taking an online course. The students also talked about the value of organization and time management along with this advantage. Time restrictions were also mentioned as a hindrance to achievement. Students therefore thought that taking an online course offered considerably more flexibility than taking the course in a traditional environment, even though they still had to find the time to do their schoolwork.

This theme is crucial to online self-directed learning. This is because:

> …the analysis of the behavioural characteristics of online students helps to intelligently adjust online education strategy and enhance the quality of self-directed learning (Li *et al*, 2018).

Online learning in higher education enables students to learn wherever they are, at any time. Students must exercise self-control in this learning environment and be intrinsically motivated. Online students must initiate, plan, and carry out their own studies. They must also self-manage their learning process. This enhances their capacity for self-directed learning. Recent studies (Yusuf *et al*., 2021; Li *et al*., 2018) have demonstrated the connection between low academic

performance and procrastination and inability to manage self-directed learning. This theme plays an important role in online learning as it may help to improve the relationship between behavioural indicators and learning outcomes, which would contribute to identifying effective self-regulated behaviour in an online learning environment.

6.2.2.3 Theme 3: Moodle SDL affective theme.

This theme focusses on the affective online learning behaviour of students. Affective has to do with feelings, moods, emotions, and self-esteem. In accordance with Pagán (2018), affective learning refers to the emotional component of learning that is expressed in students' beliefs, values, interests, and behaviours. Affective learning is concerned with:

> …how students feel while they are learning, as well as with how learning experiences are internalized so they can guide the students' attitudes, opinions, and behaviour in the future (Kuboja & Ngussa, 2015).

In this study, the codes associated with this theme are: Self-motivation, Enjoyment, Support, Self-monitoring, Self-management, Self-control, Self-reflection, Self-evaluation. Its categories are Moodle motivates students to learn more and Moodle increases sense of self.

The pre-evaluation questionnaire used in this study revealed that students had negative emotions concerning Moodle's online learning. These results are in line with the research findings of Torres and Evans (2020). According to the research by Torres and Evans (2020), it was clear from the start of an online course that students experienced negative emotions like fear and anxiety from the beginning of an online course. These negative feelings are crucial during the interaction activities with the lecturer since completing these learning tasks can be the first sign of inadequate preparation. Throughout their first year of online study, students' performance is clearly affected by their negative feelings. These negative feelings are crucial during the interaction activities with the lecturer since completing these learning tasks can be the first sign of inadequate preparation. Throughout their first year of online study, students' performance is clearly affected by their negative feelings. The study by Pentaraki and Burkholder (2017) showed that:

> … online learning caused students' emotional instability, and they felt stress and guilt over how difficult it was for them to balance all of their tasks and responsibilities.

According to their study, emotional instability among students as a result of the course's online technique is more common in the beginning and subsequently lessens as they become more accustomed to it.

The results of the post-evaluation questionnaires and interviews showed that when students engage in synchronous learning activities, such as discussions with lecturers and with other students, their levels of affective relevance and participation dramatically increase. The students' online behaviours show a variety of emotional behaviours, including enjoyment. The study found that students valued their Moodle classes. This is reflected in the students' responses in which for example S1 said "I love to do Moodle online discussions because I can ask questions about materials that I have not understood directly without having to wait for mathematics learning in the class".

Students are learning in large classes, and this sometimes makes them feel embarrassed to ask in class. Through Moodle discussion forums, they can directly ask the lecturer or other peers. According to some students, chat sessions can stimulate them to ask more deeply. The results can be seen from the interview: "I prefer to ask through the chat facility because sometimes I am embarrassed to directly ask on the discussion board that can be read by other friends." "Chat sessions are helpful because they stimulate me to ask questions." Students are more likely to feel comfortable learning online when there are opportunities for direct conversations between students and teachers or students with other students in a synchronous setting through chat and online discussion of asynchronous facilities through discussion boards. This finding is consistent with earlier research on online learning by Torres and Evans (2020), which indicates that students prefer synchronous learning environments to asynchronous learning.

According to Pentaraki and Burkholder (2017), there is "emerging evidence that suggests emotions is a discrete factor in academic online contexts that significantly contribute to student engagement and higher order learning". Students' learning and performance are impacted by their emotions. They are seen as being a regular component of school life. According to this study, students who took an online course using Moodle expressed greater emotional pleasure. This supports the findings of the study of Torres and Evans (2020), which showed that:

> …the advantage of using Moodle as a LMS is that it creates an environment conducive to the development of positive emotions and fostering constructive interpersonal exchanges during the learning process.

Recent research has demonstrated the significance of emotions in the online learning process by highlighting how they affect academic performance (Pagán, 2018; Kuboja & Ngussa, 2015). Feidakis *et al's* study found that "frustration, fear, anxiety, apprehension, shame/embarrassment, enthusiasm/excitement, and pride are among the emotions experienced online" (Feidakis *et al,*.

2014, p. 45) This finding supports the idea that emotion functions by integrating cognition, motivation, and action.

Pentaraki and Burkholder (2017) hypothesized that feelings permeate online learning environments. They have a significant influence on how students behave in academic settings. If the lecturer critiques the student's argument, the student could feel bad, like embarrassed. Students can, nevertheless, experience pleasant feelings (such as interest) while working on a task and even take pleasure in their learning activities. According to a study by Torres and Evans (2020), while negative emotions are more frequently linked to poor grades, happy emotions can indicate a creative way of thinking and the ability to reflect on ideas. Anger, frustration, humiliation, anxiety, and boredom, on the other hand, have been linked to poorer performances and external regulation, whereas enjoyment, hope, and pride have been positively connected with effort, self-regulation, and more sophisticated learning processes. Also, it has been suggested that unfavorable feelings can change how students employ their motivation and cognitive methods (Kim et al., 2014). Furthermore, it has been established that e-learning students may encounter particular negative affective states like anxiety, boredom, fatigue, and confusion during particularly difficult assignments. Additionally, some research has shown that discussing one's own emotions with others or doing so in a student community can help students achieve more in the learning process (Pekrun & Perry, 2014).

According to Hewson's (2018) research, the growth of self-directed learning in online learning appears to be related to emotion, academic success, and the learning experience. This study discovered a mediation role for emotional stability in the association between self-directed learning and perceived academic control. High levels of negative emotion experienced by students were not linked to good academic control and self-directed learning, suggesting that lecturers' efforts and students' negative emotion experiences in online courses are required to raise students' awareness of their academic progress.

Emotions therefore have a negative or a positive effect on engagement in online learning. In the context of online learning, emotion can either impede or stimulate learning, support self-regulatory processes, or lead to various problem-solving techniques. Hence, lecturers should create and prepare online classes that reflect the dynamic impact of emotions on the learning process.

6.2.2.4 Theme 4: Moodle self-efficacy theme.

This theme focusses on the academic self-efficacy online learning behaviour of students. Academic self-efficacy is the belief that one will succeed in their academic endeavours. Improving online education, which has the potential to be a crucial factor in academic performance, requires a clear understanding of self-efficacy in learning (Peechapol, Na-Songkhla, Sujiva & Luangsodsai, 2018). According to Bandura (1997), self-efficacy is the conviction that one can plan and carry out the actions required to achieve a goal. Hence, self-efficacy has to do with people's confidence in their abilities, particularly to overcome challenges and successfully accomplish a task. Generally, it is the individuals' overall belief in their ability to succeed. In this study, the codes associated with this theme are Self-belief and Personal responsibility. This theme is also associated with these categories: Moodle helps to instill self-belief skills, increases.

This theme has to do with an individual's ability to apply his or her Moodle skills to a wider range of educational related tasks. It takes into account how people perceive their ability to use Moodle effectively. Hence, Moodle self-efficacy refers to one's view of their Moodle usage skills. According to this study, Moodle self-efficacy refers to a person's view of their own abilities and competencies to utilize Moodle successfully to complete academic tasks. So, one's Moodle self-efficacy is a determination of their level of Moodle proficiency. It has to do with self-efficacy, which is the belief that students have in their ability to utilize Moodle effectively and how well that belief will affect their self-directed learning. As a result, Bandura's self-efficacy beliefs and Moodle self-efficacy can both be conceptualized as adjunct constructs.

The results of this study demonstrate that Moodle improves students' feeling of self. Their confidence in online learning increased as a result. Their sense of confidence and self-worth has grown. One of the benefits mentioned by students was their ability to assist others when necessary and their personal ability to perform any assignment, demonstrating how their confidence had increased in the class. One of the students, for example, commented on how their confidence had increased: "it also helped me to improve my self-esteem when I am communicating with others" (S1).

This research found that Moodle improved the students' self-efficacy with technology. This is as a result of Moodle boosting leaners' confidence in their technological aptitude. Students said during the interviews that Moodle has given them more confidence when learning online. The components of computer self-efficacy, according to Teo and Koh (2010), include advanced computer abilities, media-related skills, and web-based skills.

The findings from this study, as described in the preceding paragraphs, are compatible with those of the studies by Pan (2020), and Lim, et al., (2016). Both of these studies revealed a connection between academic self-efficacy and student-to-student interaction during online learning. According to these studies, higher levels of self-efficacy for online learning are associated with better learning outcomes in online courses. Self-efficacy is a reliable predictor of learners' satisfaction with online learning for the attainment of SDL, according to Thongsri, Shen, and Bao's research from 2019. On the other hand, Abdullah and Mustafa (2019) postulated that:

> …students who believe they will experience much difficulty comprehending online material are apt to hold a low sense of efficacy for learning it, whereas those who feel they can handle the information-processing demands should feel more efficacious.

Students are more likely to engage in learning-related activities when they feel more efficacious about doing so. Students learn about their level of learning when they complete exercises. The belief that they are understanding the content increases effectiveness and motivation. If students think they can perform better by changing how they approach their tasks, the notion that little progress is being made may not detract from their efficacy and motivation.

Research has revealed two important patterns regarding self-efficacy. One is that a student's willingness to participate in and persevere in challenging tasks increases as self-efficacy rises. According to Beach (2017), self-efficacious learners are more likely to set higher goals for themselves, to accurately self-monitor, and to positively self-react. They also inclined to persevere despite having trouble learning. So, it is reasonable to claim that students' self-efficacy enhances the likelihood that they will persevere through a challenging assignment they might otherwise give up on. Strong levels of self-efficacy seem to keep students going until they pick up the skills and techniques they need to finish a task. Second, improved self-efficacy immediately improves academic performance by raising both the quantity and quality of information processing. High-efficacy students, for instance, are more likely to utilize a wider variety of methods, use them more flexibly, monitor their comprehension better, and process information at a deeper level, according to research reviewed by Pan (2020). As a result, self-efficacious learners put out more effort to achieve academic goals and aim for higher levels of academic achievement than underachievers, who aim for the lowest possible levels of performance (Beach, 2017).

As a result, there is a significant relationship between self-efficacy, academic achievement, and online self-directed learning. According to Mlambo, Rambe, and Schlebusch (2020, p. 7) study from 2020, “students who are effectively self-directed tend to have higher academic self-efficacy.

Students with high and low levels of self-efficacy for learning carry out tasks in different ways". High efficacy students might see the task as a challenge and put up the necessary effort to master it in order to foster a positive learning environment. Low efficacy students could try to avoid the work and so disrupt the class. High levels of self-efficacy and optimism have been proven to significantly and favorably influence achievement in a range of information-related tasks by reducing the negative effects of emotions like irritation and frustration. In this regard, Pagán, (2018) argues that:

> …self-efficacy is the key to success in all activities including online learning. Hence, the understanding of the source of self-efficacy in online learning context is important.

Research done by Cho and Cho (2017, p. 82) found that "students who have high academic self-efficacy for learning are more likely to engage in self-directed learning (e.g., set goals, use effective learning strategies, monitor their comprehension, evaluate their goal progress), as well as create environments that are conducive to learning (e.g., eliminate or minimize distractions, find effective study partners)". Students who have strong levels of academic self-efficacy engage in online learning more readily, persist longer when they encounter difficulties, and achieve at higher levels during online learning (Teo, Huang & Hoi, 2018).

From the discussions above, it is clear that the cognitive, behavioural, affective, and self-efficacy skills are important in influencing student preparedness for Moodle online self-directed learning at universities.

6.3 The Emergent theory

6.3.1 Introduction

In this section of the study, the focus shifts from description and analysis to synthesis and theory creation. The theory discussed in this section includes concepts that relate to one another and helps to understand how to support students' self-directed learning. Each concept and relationship are based on data, which were coded, memoized, and repeatedly run through to reach higher levels of abstraction. It is from this process that a theory emerged. The support requirements for students' online self-directed learning are met by this emergent theory. It offers solutions to issues related to online self-directed learning. This could help university students study more effectively through self-directed learning. The views of SDL and Moodle in the literature, the data findings, and the themes that emerged from this study are all reflected in this theory.

6.3.2 The presentation of the theory

The Moodle Self Directed Learning Theory (MSDLT), which resulted from this study, is depicted visually in Figure 6.1. The main aim of designing this learning framework is to help improve Moodle self-directed learning. The building blocks of this learning theory are online computer literacy prior knowledge, the usability of Moodle, the SDL perspectives which guide the self-directed learning process, the behavioural indicators of the SDL learning process, and the outcomes of the self-directed learning process (see figure 6.1).

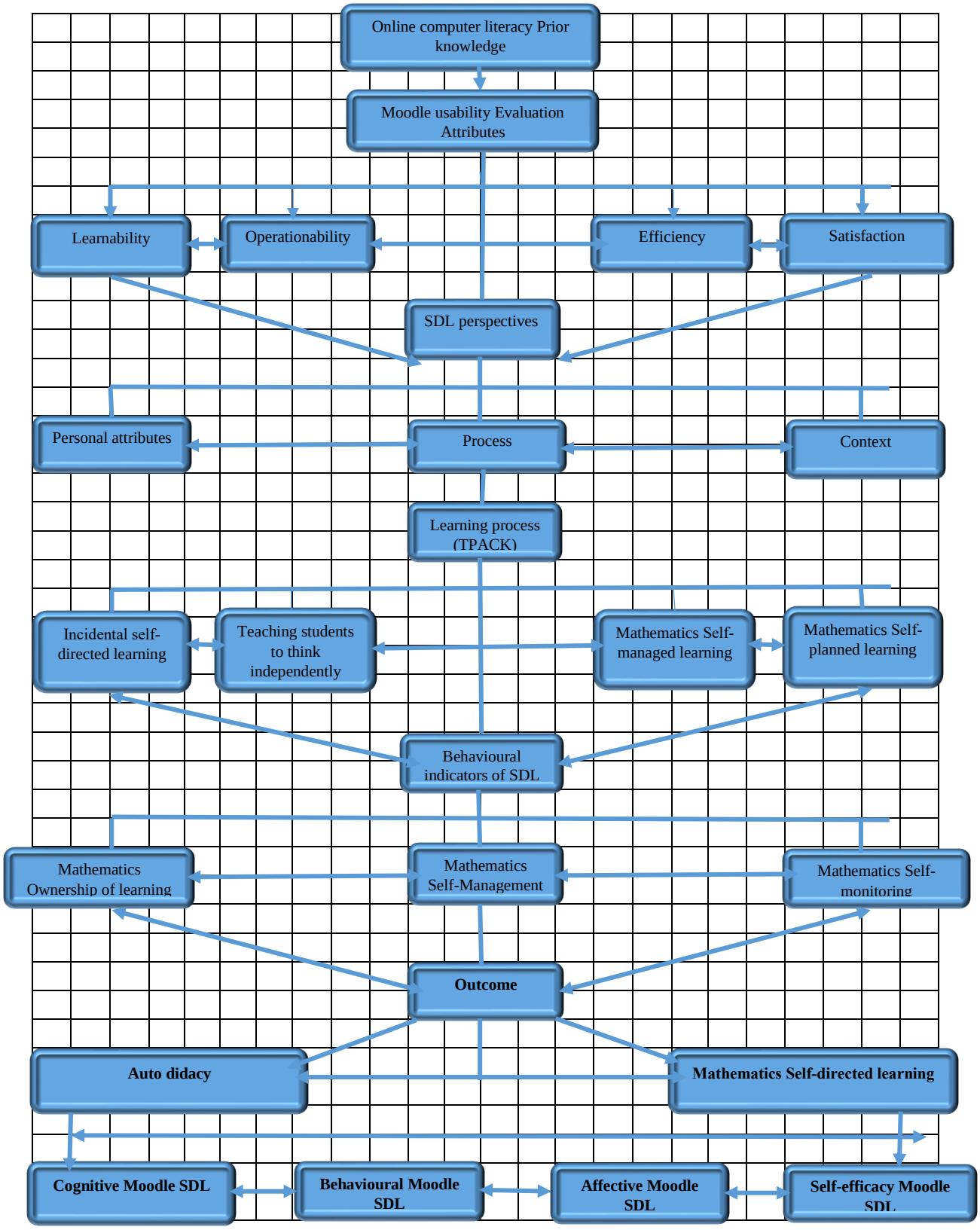


Figure 6.1: The Moodle self-directed learning theory.

6.3.3 Discussion of the main aspects of the Moodle Self Directed Learning Theory

6.3.3.1 Online Computer Prior knowledge

Prior knowledge is the knowledge a student already possesses before encountering new information. According to the research by Butcher and Sumner (2015), many university students start their online programs with little computer experience but quickly become engrossed in the use of technology for communication and learning. For them, this is quite overwhelming. O'Donnell, Sharp, Wade and O'Donnell (2014) claim that:

> …the students' computer prior knowledge is important because it influences students' online learning behaviours and has a bearing on the relationship between these behaviours and students' eventual online learning skills outcomes.

Research and theory in cognitive psychology can be used to explain why online prior knowledge is so important for online learning. Prior knowledge that is relevant serves "as a framework for new information, allowing it to be integrated into a flexible knowledge representation that may be used to many contexts" (Hixon, Barczyk, Ralston-Berg and Buckenmeyer, 2016, p. 29).

Butcher and Sumner (2015) state that students' lack of essential prior understanding of online computers is a prevalent issue confronted by lecturers in university online education. According to Shen, Cho, Tsai, and Marra's (2013, p. 16), "a student's self-efficacy for online learning was correlated with the number of previous online courses they had taken". They discovered, specifically, that students who had greater experience with online learning before showed stronger self-efficacy to finish an online course and work with other students on academic tasks. In line with this, a study by Wang, Shannon, and Ross (2013, p. 317) discovered that "students who had previously completed online courses used learning strategies that were more efficient". Students that employed more efficient learning techniques also showed higher levels of motivation for their online homework.

These findings imply that students who have had past online learning experiences are better prepared to effectively complete their online courses. Students with prior experience not only have a higher chance of becoming successful learners, but they also have advantages in the affective domain of learning, such as a better attitude and more course satisfaction (Wang, Shannon & Ross, 2013). These results imply that students who have more extensive prior online learning experience are more likely to see online learning favorably because they are more likely to be successful, more confident in their ability to succeed, and more equipped to succeed.

Additionally, Butcher and Sumner's (2015, p. 26) research revealed that “students with more online experience (those who had completed seven or more online courses) differed in their ratings of items related to clear expectations for interaction and ease of navigation”. Online learners with greater experience rated these items as being more crucial than those with less experience. Ralston-Berg (2014, p. 34) argues that “students' opinions of the quality of online courses differ from those who created the QM standards, which is generally supported by the fact that online students perceive quality differently dependent on prior online experience”.

So, prior knowledge is expected to have a significant impact on how students behave and approach online learning tasks. According to some other studies, the results of upcoming online courses may be significantly influenced by prior online learning experiences (Hachey, Wladis & Conway, 2014; Butcher and Sumner, 2015). Despite the fact that this study was constrained by the fact that it only examined one online undergraduate course, Haverila (2011) discovered that prior learning experience was a significant factor in learners' perceptions of the effectiveness of online learning and learners' productivity. The results of a more recent study by Morris and Rohs (2021), which included 129 online courses at a sizable urban community college, demonstrate that earlier performance in online courses is substantially connected with future success in online courses.

Butcher and Sumner (2015) claim that prior knowledge is linked to students' ZPD and is used to predict online learning behaviours. The zone of proximal development, according to Vygotsky (1979), is:

> …the distance between the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers, and the level of actual development as determined by independent problem-solving.

The Zone of Proximal Development (ZPD), one of Lev Vygotsky's most well-known concepts, indicates the potential level a person could reach with the assistance of other competent people. According to Vygotsky's research, education should aim to place students as much as possible in their own ZPDs by giving them engaging tasks, worthwhile learning opportunities, and problems that are challenging enough to warrant help from knowledgeable peers and facilitators. According to Vygotsky, if the right help is given to a student who is in the ZPD for a specific task, it will provide them with the boost they need to complete the task.

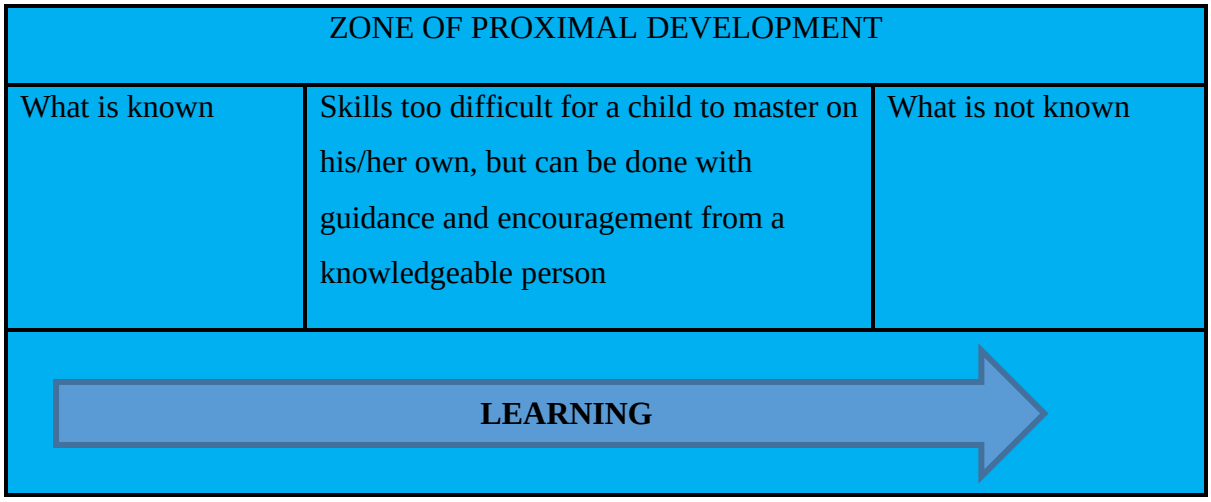


Figure 6.2: The Zone of Proximal Development (ZPD)

This learning theory conceptualises that for students to be truly online self-directed, the starting point should be what is known by students, their abilities, and capabilities. Their online education should be built upon the foundation of their earlier online knowledge. The students' ZPD should include their online education as well. This learning theory for Moodle Mathematics Self-Directed Learning takes into account the students' ZPD and prior knowledge as a starting point. The student and his or her actions serve as the starting point. The researcher contends that the lecturer can support, model, and keep an eye on these behaviours.

In order to achieve self-directed discovery learning inside the ZPD, Moodle should be employed as a technical mediation tool that mediates the learning process. Moodle acts as a facilitator, allowing students to continuously push themselves and create new knowledge through collaborative and experiential learning.

6.3.3.2 Moodle usability evaluation attributes

The International Organization for Standardization defines usability as

> …the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of user (ISO 1988).

Usability qualities, according to Capece and Campisi (2013), mostly concentrate on how to use Moodle. Moodle's usability attributes make it easier to understand how useful and effective it is for teaching and learning (Navimipour & Zareie, 2015). The Moodle navigation skills assist students easily access the content they're seeking for thanks to the usability attributes.

According to Nielsen (1994), usability improves learnability, which in the context of online learning refers to users' capacity to efficiently acquire and retain knowledge and skills. Moodle Perceived Usefulness (MPU) and Moodle Perceived Ease of Use (MPEOU) are Moodle usability factors that help students. Davis (1989) define Moodle Perceived Usefulness (MPU) the degree that measures how much a student thinks using Moodle will help him or her perform better. Perceived Usefulness can therefore be a strong determinant of intention to use Moodle. How effectively lecturers can use a Moodle to engage students has a significant impact on the Moodle's value in the classroom. The most crucial element in conceptualizing the calibre of teaching and learning in a university setting is how useful Moodle is. If the Moodle teaching system aids lecturers and students in attaining their goals, they will adjust to it. Perceived simplicity of use has an impact on perceived usefulness as well. Moodle Perceived Ease of Use (MPEOU) refers to the "degree to which a student believes that the use of a Moodle will be uncomplicated" (Davis, 1989, p. 325). MPEOU is defined as "the extent to which a student believes that using Moodle will be relatively effortless" (Jonas & Norman, 2011, p. 150).

Usability is described in terms of learnability, operability, efficiency, and satisfaction in this learning theory. The effectiveness of e-learning systems has an impact on how well students succeed in online learning, according to Esgi (2013). Students struggle to use online learning systems when their usability is poor. The four usability evaluation characteristics listed below helped to develop this learning theory:

- Learnability: Concerned about how simple it is for students to use Moodle for the first time and complete simple activities. Students will be better able to build their mathematical problem-solving abilities without frequent coaching if they find Moodle to be simple to learn.
- Operationability: concerned with the students' capacity to use Moodle's features. This contributes significantly to Moodle's user-friendliness. This will support students' independent study of mathematics.
- Efficiency*:* This relates to how quickly students can complete tasks after becoming familiar with Moodle. This might lead to a high degree of productivity when teaching mathematics.

- Satisfaction: concerned about how pleasant Moodle is to use. Students should enjoy using the software and feel satisfied with the amount of time they spent in achieving self-directed learning when it comes to learning mathematics.

6.3.3.3 Perspectives on Self-Directed Learning

This learning theory incorporates Garrison's Three-Dimensional Model of SDL. Garrison's model of SDL involves the personal attributes as well as a learning process as the perspectives of SDL and the learning context (Garrison, 1997).

Personal Attributes

An attribute is defined as a person's trait or characteristic. When using Moodle, personal attributes refer to how motivated and capable students are to take ownership of their learning (Deci & Ryan, 2012). Hence, personal attributes pertain to a learner's motivation for learning and capacity for taking ownership of their education. It also includes resources and cognitive strategies. The learning outcome is influenced by the learners' individual traits, prior knowledge of the subject matter, and prior exposure to the learning setting in a given learning context. Together with their past content knowledge and prior experience with the learning context, a student's personal traits include all the qualities they bring to a particular learning setting. All individuals are capable of learning on their own, but the extent to which they do so depends on a variety of personal factors, such as learning motivation, self-efficacy, self-esteem, conscientiousness, openness to new experiences, and even the level of intelligence.

The correlation and multiple regression analyses used in the study by Cazana and Schiopca (2014) looked at the connection between personality factors and students' self-directed learning. The findings demonstrated a relationship between personality traits and self-directed learning. Hence, self-directed learning is influenced by students' personal attributes.

Processes

Processes refer to students' autonomous learning processes (Deci & Ryan, 2012. These processes include planning, monitoring, and evaluating one's learning. These processes encourage autonomous thought and self-directed learning. They also improve problem solving skills. The process of organizing, observing, and assessing one's own learning is where students' autonomy is most primarily manifested. SDL aims to support students in gaining autonomy over their

learning. Simply said, autonomous learning refers to the capacity of the learner to carry out tasks without external direction.

Students have more control over how, when, and with what content they interact in the Moodle learning situations where the curriculum is structured online. Students must monitor and modify their behaviour and activities in relation to the particular learning situation in order to demonstrate this flexibility. Students understand that they are responsible for their own learning rather than relying on an outside source, like a teacher. An individual who is self-directed tends to actively participate in the learning processes, including information gathering, planning, and evaluation of the learning activities. Active learning techniques can boost student engagement and enhance learning and performance.

Context

The term context refers to all environmental factors and how they affect the student's level of self-direction. Both the support and instructional design aspects are included in this. The resources, organization, and type of tasks inside the learning context are design elements. These resources might be created by the instructor as instructional support and integrated into the particular learning situation. Similarly, the specific learning context may decide on the structure of the course.The assistance may come via peer collaboration and communication or from the instructor's feedback.

6.3.3.4 Learning process: Moodle and SDL

According to Gibbons (2002), SDL has different stages that range from a low degree of self-direction to the highest degree of SDL. The first stage is known as Incidental self-directed learning, and it entails sporadically integrating SDL activities into otherwise teacher-directed courses or programs. Teaching students to think independently is the second phase. The lecturer's programmes need to have a strong emphasis on the individual search for meaning through inquiry, problem-solving, exploration, and creative activity. The third phase is self-managed learning, which entails courses or programs that students complete on their own time and with the aid of learning aids. The fourth phase is self-planned learning, which refers to courses or programs where students work toward course objectives through original activities. The fifth step is self-directed learning. Students choose the outcomes, create their own activities, and pursue them in their own manner in these courses or programs.

Behavioural indicators of SDL

For lecturers to promote SDL among their students, they must be aware of the behavioural indications of SDL. The most significant behavioural indications of SDL, according to Deci and Ryan (2012), are ownership of learning, self-management and self-monitoring, and extensions of learning. Lecturers can keep an eye on whether their students are participating in SDL activities with the use of these behavioural indicators. In turn, knowing this could be helpful knowledge for developing instructional tactics.

Ownership of learning

Ownership of learning has to do with personal responsibility. Personal responsibility, according to Brockett and Hiemstra (1991, p. 27), "is the cornerstone of self-direction in learning". Students who are accountable for their education take ownership of it. They are able to establish their own educational objectives and are willing to live with the results of their decisions. As a result, students should develop a sense of ownership over their learning and identify, decide, and explain their own learning goals.

Self-management

Self-management is the phrase Deci and Ryan (2012) use to characterize the behavioural task control component of managing learning activities. Self-management in self-directed learning refers to the process of controlling oneself to accomplish one's objectives. If planning, continuous implementation, and self-evaluation are not balanced out, managing ourselves can be very challenging. Growing self-motivation, making detailed plans, carrying out continuous activities, and evaluating obstacles encountered while learning are the processes in self-management.

It is important for students to learn how to manage resources and tasks from beyond their own. Students should also learn how to make wise judgments, prepare for themselves, and manage their time for themselves. To accomplish their learning objective, students should regularly and critically reflect on what they have learned and take the initiative to solicit feedback from lecturers and peers. his is a recipe for Mathematics self-directed learning. In SDL, a high level of self-management is crucial, and students must use different strategies to deal with a range of issues and difficulties.

Self-monitoring

Deci and Ryan (2012) claim that self-monitoring concentrates on the internal to the students cognitive and metacognitive aspects of learning. All learning processes include cognitive processes, such as thinking, understanding the information, and incorporating new knowledge into the existing knowledge base. The ability of a student to reflect on their learning is referred to as metacognition, which is defined as thinking about thinking or learning to learn. This SDL component is similar to self-regulated learning. Deci and Ryan (2012) recommend controlling one's learning as a result by self-monitoring, self-evaluating, and self-reacting to the learning activities and performance. Self-monitoring involves internal cognitive processes, yet it can still be influenced by outside influences, such as feedback from a teacher or others. Therefore, it is important for students to acquire skills that will enable them to successfully complete the challenges they set for themselves through self-monitoring.

6.3.3.5 Outcome

The ultimate outcome of any self-directed learning is autodidaxy. Autodidaxy means self-teaching. It involves learning situations where students have the freedom to decide what they will learn, where they will learn it, how they will learn it, and how they will evaluate it. The crucial role that lecturers should play is encouraging students to set up learning challenges and assisting them in becoming competent in controlling and supervising their learning, which will result in autodidacy or self-teaching.

According to Asiri and Shukri (2020), a highly self-directed student is:

> …an autonomous learner, who believes his/her own efforts can cause his/her behavioural changes, similar to the learner with a high level of internal locus of control.

According to Asiri and Shukri (2020), a student with a high level of internal locus of control believes that he or she has control over the outside factors that may influence how they learn. As a result, a highly self-directed autonomous learner demonstrates initiative, independent perseverance in learning, acceptance of responsibility for personal learning, self-discipline, and openness to learning chances. He or she has the capacity to decide what is worthwhile and to make decisions that are consistent with self-realization. Students should therefore be encouraged to do more independent work so as to be autonomous.

6.4 The role played by the themes in Self Directed Learning

According to earlier studies (Stephan, Stefan, and Gläser-Zikuda, 2019; Peerapolchaikul, Sueale, and Panadda Rojpibulstit, 2019; Bhat M.A. et al., 2016; and Peerapolchaikul, Sueale, and Panadda Rojpibulstit, 2019), learning environments impact more than just the cognitive, behavioural, affective, and self-efficacy aspects of learning. One sign that self-directed learning has been accomplished in Moodle teaching and learning is the development of online cognitive, online behavioural, online emotional, and online self-efficacy abilities. These skills are the outcomes of the students' independent learning.

Student engagement and performance in Moodle learning are significantly influenced by self-efficacy in the learning process. It is crucial for students to feel confident in their technological abilities because Moodle courses are taught online. Self-efficacy, according to Peerapolchaikul, Sueale, and Panadda Rojpibulstit (2019), is a key element in determining how frequently and successfully people use Moodle for self-directed learning. Highly self-directed students believe they can carry out their own plans and persevere until they reach their goals. So, through its impact on self-set goals, self-efficacy can assist predict students' performance accomplishments both directly and indirectly.

The outputs of students' self-directed learning in Moodle should also demonstrate their cognitive abilities. Cognitive abilities are the mental faculties required for learning, information processing, logic, and problem solving (Bhat M.A. *et al*., 2016). According to a 2017 study by Meza-Fernandez and Seplveda-Sariego, Moodle encourages cognitive learning. Active, constructive, and long-lasting learning are all characteristics of cognitive learning. It involves students in the learning process and teaches them how to better use their brains to form connections when learning new information. Research have revealed that a person's cognitive abilities are a determining element of their ability to learn; in other words, when cognitive abilities are high, learning is quick and simple (Bhat M.A. *et al*., 2016; Pentaraki & Burkholder, 2017). These studies show that learning is difficult when cognitive abilities are lacking. Cognitive abilities let students be critical, creative, and imaginative, which boosts their self-directed learning beyond simple observation of information and memorization.

Cognitive learning has some educational benefits. It enhances understanding and motivates students to learn via doing. Students can investigate the subject and gain a greater grasp in this way. The ability to solve problems is improved. Students can use the transferable problem-solving and study abilities they develop through cognitive learning in any subject.

Good online behaviour is one of the abilities that may be acquired through online self-directed learning in Moodle learning. In order to build positive behaviour management in the online classroom, lecturers should foster a positive environment. Lecturers should make it obvious what each module's and lesson's goals and objectives are in order to encourage appropriate online behaviour. The students can visualize what they must complete during class time by clearly stating the lesson's learning objectives and goals. The lecturer should outline what is expected of students in terms of behaviour. In a traditional classroom, all students are familiar with the rules, but in this new virtual environment, they are unsure of what to anticipate. The teacher should be very explicit about the expectations for good behaviour in the online classroom.

The affective components of learning are impacted by online learning environments. Due to the nature of online learning as a distant learning experience, there are obstacles to student involvement and learning. According to Stephan, Stefan, and Gläser-Zikuda (2019), these obstacles are the main causes of the low student engagement and greater attrition rates in online courses. Emotions are a potent weapon in the battle for the attention, engagement, and persistence of online students. Students frequently misbehave or disrupt lessons when they are anxious, overexcited, or stressed out. But they may communicate their feelings in more socially acceptable ways after they realize how their emotions affect their behaviour. The ability to detect and control one's emotions depends on both self-awareness and self-management; the former helps students do so. These two abilities enable students to identify their strengths, cultivate a growth mindset, restrain impulses, and set goals.

This learning theory is recommended for Moodle teaching to promote self-directed learning.

CHAPTER 7: CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

7.1 Conclusion

The problem that triggered this study was that university students find it difficult to adapt to the self-directed learning environment found in universities. Students find it difficult to adjust to the self-directed learning that is becoming more and more emphasized in universities. The fundamental aim for this study was therefore to investigate the students' perspectives on Moodle in promoting mathematics self-directed learning. This study therefore provides useful data about students' perspectives towards Moodle self-directed learning. Investigating this topic required one main research question and four sub-questions, namely, what relationship exists between Moodle Learning Management system and students' self-directed learning, how do students use Moodle Learning Management system for self-directed learning, to what extent do students perceive themselves to have the necessary skills to use Moodle for mathematics self-directed learning, after using Moodle, how do students perceive the improvement of their Mathematics self-directed skills, and how do students perceive the usefulness, effectiveness, and ease of use of Moodle. These questions were informed by three research objectives, namely, to identify what relationship exists between Moodle Learning management system and students' self-directed learning at a South African university; to evaluate the readiness level of self-directed learning among first year mathematics students; and to find out if the diploma in Agriculture students exposed to Moodle mathematics teaching would exhibit the characteristics of self-directedness.

The study found that the students have a high level of SDL behaviour (mean is 4.43, and the standard deviation is 0.68, the relative standard deviation is 4.3 ± 15.3%.). The data is tightly clustered around the mean which represents a high score. Students were found to be able to use the Moodle LMS to construct knowledge independently with minimum supervision. The use of Moodle enabled students to discover concepts. This is a student constructivist way of teaching which promotes SDL. In constructivist Teaching students construct their own understanding rather than having it delivered or transmitted to them. Overall, according to student perceptions, the use of Moodle improved their independent work which promoted self-directed learning. Self-directed learning improved students' motivation and confidence.

Based on the quantitative and qualitative data analysis of this study, the researcher concludes that Moodle is a Learning Management System which may be effectively used to promote students self-directed learning. This is because this study revealed how students used Moodle for effective

online independent learning. Nonetheless, the students agreed that there were some challenges that needed to be resolved for Moodle to be used more successfully. The students' inability to efficiently use Moodle was one of the main problems they faced. The need for more Moodle training opportunities was expressed by the students.

The researcher acknowledged the need for improved student training on the efficient use of Moodle to encourage independent and self-directed learning based on the findings of this study. First-year students need assistance getting used to university teaching and learning, with an emphasis on online learning in particular. Due to the style in which they were taught in high school, many first-year students enter the university unprepared for online self-directed learning. They experience a gap between the academic culture in high school and the culture of the university. As a result, these students therefore need to be well versed in online learning. Online students must initiate, plan, and carry out their own studies. They must also self-manage their learning process. This enhances their capacity for self-directed learning. Recent studies (Yusuf *et al*., 2021) have demonstrated that poor academic achievement and procrastination result from an inability to manage self-directed learning.

This study draws the conclusion that Moodle can be used as a learning management system to support students' self - directed learning based on the study's findings. In Moodle's online learning environments, self-directed learning is a key component. The necessity for online self-directed learning has increased as a result of the current global pandemic scenario. Online self-directed learning is becoming a significant long-term strategy for many postsecondary schools, according to a recent higher education survey (Pan, 2020). Higher education institutions must offer high-quality self-directed learning programs given the rapid expansion of online learning and the significance of this trend for postsecondary schools. Students should have the freedom and autonomy to select the what, why, how, and where of their learning through self-directed learning.

7.2 Recommendations

Against the background of the data collected from the literature review, questionnaires, and interviews, the researcher offered the following recommendations based on the empirical research findings of this study and participants' perceptions of Moodle self-directed learning:

Recommendation one: **Closing the digital divide**

Digital literacies need to be embedded into courses and modules so that they can be learnt in the context of the discipline. Universities should play an important role to ensure that all first-year

students can access the required resources needed for Moodle online learning. This can be in a form of subsidy on the internet data, or they should seek partnership with telecommunication companies who may provide free data for the students to engage in Moodle online learning.

Recommendation two: **Closing the technological gaps and technical skills:** First year university students have technological gaps. Students should be awarded time for Moodle online training. Universities should close the technological gaps by equipping students with computer literacy skills. All first-year university students should enrol for an End User Computer Module or course. Students have to be trained on how to use their gadgets to access material on online platforms and to use office-word tools.

Recommendation three: Basic technical skills, motivation and independence

Universities should help students learn the fundamental technical abilities needed to use computers. Basic computer knowledge is necessary for Moodle self-directed learning to succeed. They comprise the ability to create new documents, work with word processing software, browse the Internet, and install programs. Online self-directed students must have the determination, desire, and motivation to succeed on their own if they are to succeed. Independent thought, personal motivation, responsibility, and a certain amount of maturity are requirements for online learning. Higher education schools must offer excellent self-directed learning programs. Students should be able to plan, develop, adapt, and change in a digital, interactive, and global world. They should also be able to take ownership of their learning.

Recommendation four: **Constant support and provision of training material**

This study recommends that universities should provide support in the form of designated technology mentors in libraries, classrooms and computer laboratories. Such mentors should be responsible for issues relating to technological resources. First year university students need full technical support, especially in the first semester.

Recommendation five: **IT training and awareness programmes**

Universities should introduce IT training and awareness programmes for students at the beginning of their first year. Such training should focus on how to use Moodle learning platform. This would equip students with the necessary skills to perform their learning tasks effectively.

Recommendation five: New university students

It is recommended that new university students be helped to transition from high school to university. Many first-year students are unprepared when they enroll in universities. It is not that they are not intelligent or driven. They instead notice a disconnect between the intellectual atmosphere of high school and the university. University standards, rules, and practices are entirely different. They need to be taught how to be university students because of this. The practical skills and approaches required to assist these incoming students in learning the standards, regulations, and procedures of their new educational environment are taught by helping first-year students adjust to university. The institutional cultures of all universities ought to include this. Everything that occurs on and around the university campus is influenced by institutional culture, including how lecturers teach, how new students are welcomed and treated, and how students are made to feel at the institution. Adonis and Silinda (2021) assert that institutional culture is at the core of higher education and that it has a direct and indirect impact on the educational experiences that students have in the classroom. It also determines whether the university is prepared to accept the diverse student body, which is representative of the diversity within the nation.

Recommendation six: University orientation programs

Based on the previous recommendation, this study further recommends that universities invest a significant amount of energy and resources in orientation programs designed to assist first-year students in developing a sense of self as students and a sense of affiliation with their institution and course. Several programs also place a strong emphasis on educating students about academic expectations, standards, and the kinds of intellectual abilities necessary to succeed in higher education. Although the majority, if not all, institutions provide a variety of orientation programs, surprisingly little is known about how well they aid students in adjusting to university life.

Recommendation seven: University training and support

Another important element of high-quality online education is support and training from universities. Many researchers contend that lecturers play a different role from that of traditional classroom instructors when they teach online courses. Such new roles for online instructors require training and support. According to certain case studies of faculty development programs, these initiatives can help lecturers shift from face-to-face instruction to online learning.

Universities should often provide training for lecturers who are engaged in the delivery of online courses. Lecturers who conduct online courses should frequently receive training from time to time. Online course development and design is a common activity for lecturers who deliver their courses online. Lecturers need facilitation and course design abilities in order to teach effectively.

Recommendation eight: Effective time-management skills

Students should be capable of effective time management. The majority of university courses are not taught in real time. Classes do not have specific start or end times. The flexibility of online learning is one of its many advantages. It can be a disadvantage for a student who procrastinates, finds it difficult to maintain a regular study plan, or needs daily reminders from a lecturer to finish tasks. Time management abilities are not something that just appear. Students have to learn them. They will benefit for the rest of their lives once they master efficient time management techniques.

Recommendation eight: The institution under study

The inability to use Moodle effectively has surfaced as one of the major challenges. The university has an academic support and division whose responsibility is to assist both lecturers and students with all academic training programmes and support. ts. This division ought to provide Moodle learning and online training programs for first-year students. For students to become proficient in utilizing Moodle as an online learning management system, more training opportunities for them are regularly required. Students must therefore be taught how to use a number of Moodle capabilities offered by this platform, especially the communication tools like the discussion forum.

Recommendations for further research

This mixed method study strengthened the understanding of self-directed learning of first-year university students. The following recommendations are made for additional investigation because it may help to further broaden the body of knowledge:

- Studies at a single institution are inevitably constrained. The findings of this study may be more widely applicable if they were replicated at other universities.
- Future research needs to be done on the Students Affective Attitudes towards Moodle. Understanding students' attitudes toward Moodle is critical if it is to become both more effective and widely used (Djamel & Mohamed, 2021).
- The study recommends that future research emotions in Moodle-supported learning environments be done. The question of how students experience online learning settings

emotionally and how these emotions are dealt with has not yet been fully addressed, despite a growth in research on emotions in technology-supported learning environments in recent years.

- Understanding students and acknowledging diversities in their online learning behaviour is the key to design effective online lessons which will promote self-directed learning. For this reason, this study recommends for future research, the study on Moodle teaching and learning styles that will promote self-directed learning.
- The study further recommends that future investigations should be carried out on the impact of Moodle blended on students' academic performance. Blended learning, which combines in-person and online instruction, is commonly used in higher education and is referred to as the new normal in course delivery by some scholars. In order to provide students more freedom to customize their educational experiences, blended learning, also known as hybrid learning, blends digital media and technology with traditional instructor-led classroom activities. Since more students have access to computers and other devices, blended learning is becoming a more popular method of meeting student needs. Blended learning enables a completely integrated classroom where the requirements of all types of learners may be fulfilled by making in-person and online learning complementary.

7.3 Limitations of the study

A major limitation of the study is its sample selection and size. All the respondents were students at one of the universities in South Africa. This study therefore has a lack of generalizability due to one institution and a few participants. The results of this study cannot be generalised to a large population because the participants in this study were chosen from the same university. It is advised that additional research be conducted with responders from different universities to confirm the study's findings.

The fact that the SDLRS and MSDLTS are both dependent on self-evaluation, which could not be an accurate reflection of reality, is another weakness of this study. It is possible that the students' own evaluations do not often match up with their actions. According to Johnson and Christensen, students may not always be conscious of their own learning processes (2020). Students can consequently be unable to comprehend or evaluate their independent learning.

The findings of this study are based on the opinions of students who were questioned and interviewed on Moodle's impact on self-directed learning. The self-reporting component of this

data collection technique raises the possibility of response bias. Answer bias is the propensity for respondents to provide unreliable or erroneous answers (Bogner & Landrock, 2016). When individuals are asked to self-report their behaviours, it frequently happens.

The fact that the researcher was the main tool for data collection and analysis limits this study as well. Bias is inevitable because only the researcher was responsible for gathering and analyzing the data.

7.4 Contribution of thesis to new knowledge

It is impossible to overstate the value of empowering students with the lifelong learning skills they need through self-directed learning in the twenty-first century. This study adds to the most recent body of research on self-directed learning and to the conversation on cultivating attitudes toward it among all students. Contributing to the theory and literature on Moodle Self Directed Learning Theory (MSDLT) is a primary goal of this thesis. This was accomplished through the development of a Moodle Self Directed Learning Theory, which aims to encourage students in higher education to learn on their own initiative. It also seeks to identify the teaching strategies and conditions that support successful self-directed learning in a blended learning setting.

The theory is expected to lead to a paradigm shift in how institutions approach Moodle-based, self-directed mathematics teaching and learning. It is hoped that this study's findings would provide several Moodle pedagogical integration strategies that can be used to encourage mathematics self-directed learning in South African schools and universities. The research findings should improve lecturers' teaching strategies by presenting practical knowledge that will eventually support and advance Moodle self-directed learning. The information will also be used to guide professional development programs on how lecturers and teachers can support effective learning through self-directed learning.

The findings will hopefully encourage more usage of Moodle and other ICT LMSs in the classroom. So, it is hoped that the findings would improve the teaching strategies used by lecturers. The data will serve as the basis for professional development programs that show lecturers and teachers how to facilitate efficient learning through self-directed learning. The study will make it possible to reconcile Moodle instruction with independent, self-directed learning. The findings of this study demonstrate the connection between Moodle teaching and self - directed learning. The Department of Higher Education and Training's policy makers, teachers, and other stakeholders may find the findings beneficial. They may stimulate critical reflection on the part

of lecturers to address problems associated with ICT teaching and self-directed learning the situation. The findings of this study form a rich knowledge bank of work on self-directed learning.

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APPENDICES

APPENDIX 1

Student Consent Form

Please fill in the reply slip below if you agree to participate in my study called: The investigation of the students' perspectives on Moodle in promoting mathematics self-directed learning.

My name is: _____

Permission to review/collect documents/artifacts	**Circle one**
I agree that pre and post evaluation questionnaires /interviews can be used for this study only.	YES/NO

Permission to be audiotaped

I agree to be audiotaped during the interview	YES/NO
I know that the audiotapes will be used for this project only	YES/NO

Permission to be interviewed

I would like to be interviewed for this study.	YES/NO
I know that I can stop the interview at any time and do not have to answer all the questions asked.	YES/NO

Permission for questionnaire

I agree to fill in a question-and-answer sheet or write a test for this study.	YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time
- I can ask not to be audiotaped, photographed and/or videotaped
- all the data collected during this study will be destroyed within 3-5 years after completion of my study.

If you are willing to take part in this research project, then please fill in your details below and sign. By signing below, it means that you are willing to take part in the research project. Your signature means you do not mind being interviewed, and your interview being recorded. (N.B. Anonymity and confidentiality of information will always be guaranteed).

Surname and initials: _____

Signature: _____

APPENDIX 2: ETHICAL CLEARANCE FROM WITS UNIVERSITY

Wits School of Education

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3221 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

Student Number: 332787

Protocol Number: 2018ECE024D

Dear Yeyisani Evans Makhubele

Application for Ethics Clearance: Doctor of Philosophy

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

The investigation of the students' perspectives on Moodle in promoting Mathematics self-directed learning.

The committee recently met and I am pleased to inform you that **clearance was granted**. Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

M Mabeta

Wits School of Education
011 717-3416

cc Supervisor – Dr Judah Makonye

Appendix 3: Research questionnaire: demographic characteristics and internet experience

Please put a cross on one item per characteristic

DEMOGRAPHIC CHARACTERISTICS AND INTERNET EXPERIENCE		
Gender	Male	
	Female	
Age	17-19 years	
	20-22 years	
	More than 22 years	
Internet experience	No experience	
	Some experience	
	Experienced	
	Very experienced	
Moodle experience	No experience	
	Some experience	
	Experienced	
	Very experienced	
Do you have computer at home	Yes	
	No	
How long have you been using computers	0 years	
	1-3 years	
	3-6 years	
	More than 6 years	
What is your level of computer competency?	Nothing	
	Beginner	
	Intermediate	
	Expert	
Do you have access to the Internet?	Yes	
	No	
How long have you been using the Internet	0 years	
	1-3 years	
	3-6 years	
	More than 6 years	
How much time do you often spend on the Internet in a day?	Less than 1 hour	
	1 – 4 hours	
	More than 4 hours	
What is your level of experience with on-line courses?	Nothing	
	Beginner	
	Intermediate	
	Expert	

Appendix 4: Pre-Evaluation Questionnaire

Indicate your views on items below by circling the number. For each item there is a row of numbers (1 – 5) corresponding to a five-point scale. Choose only **one** response by **putting a cross** only **one** of the numbers. The numbers stand for the following responses:

Strongly disagree	Disagree	Not agree and not disagree	Agree	Strongly agree
1	**2**	**3**	**4**	**5**

For example:
If you **strongly disagree** with the statement ***"I am self-disciplined."*** Then put a cross on number **1**

ITEM	FACTOR					
CODE	**SUB FACTOR ITEM/QUESTION**	**SD**	**D**	**NAND**	**A**	**SA**
SM	**Self-Management**					
SM1	I am self-disciplined	1	2	3	4	5
SM2	I have good management skills	1	2	3	4	5
SM3	I set time frames for my study	1	2	3	4	5
SM4	I can be trusted to pursue my own learning	1	2	3	4	5
SM5	I prefer to plan my own learning	1	2	3	4	5
SM6	I am confident in my ability to search out information	1	2	3	4	5
DML	**Desire for Mathematics learning**					
DML1	I have a passion for Mathematics	1	2	3	4	5
DML2	I have a passion to learn mathematics concepts	1	2	3	4	5
DML3	I critically evaluate new ideas	1	2	3	4	5
DML4	I like to evaluate what I do	1	2	3	4	5
DML5	I am open to new ideas	1	2	3	4	5
DML6	When presented with a problem I cannot resolve I always ask for assistance	1	2	3	4	
SC	**Self-Control**					
SC1	I prefer to set my own learning goals	1	2	3	4	5
SC2	I like to make decisions for myself	1	2	3	4	5
SC3	I always set high personal standards	1	2	3	4	5
SC4	I evaluate my own performance	1	2	3	4	5
SC5	I can find out information for my self	1	2	3	4	5
SC6	I prefer to set my own criteria on which to evaluate my performance	1	2	3	4	5

Appendix 5: Post Evaluation SDLRS-SPQ Questionnaire

The following is a bank of items perceived to reflect the attributes, skills and motivational factors required of self-directed learners. Please evaluate each item regarding the degree the item measures a characteristic of yourself. You are required to assess each item using a 5-point Likert scale as follows: Please put a cross on:

1. If you "strongly disagree" that the item measures the characteristic of yourself.
2. If you "disagree" that the item measures the characteristic of yourself.
3. If you "not sure" that the item measures the characteristic of yourself.
4. If you "agree" that the item measures the characteristic of yourself.
5. If you "strongly agree" that the item measures the characteristic of yourself.

ITEM	**FACTOR**					
CODE	**SUB FACTOR ITEM**	**SD**	**D**	**NS**	**A**	**SA**
SM	**Self-Management**					
SM1	I am self-disciplined	1	2	3	4	5
SM2	I have good management skills	1	2	3	4	5
SM3	I set time frames for my study	1	2	3	4	5
SM4	I can be trusted to pursue my own learning	1	2	3	4	5
SM5	I prefer to plan my own learning	1	2	3	4	5
SM6	I am confident in my ability to search out information	1	2	3	4	5
DML	**Desire for Mathematical Learning**					
DML1	I have a passion for Mathematics	1	2	3	4	5
DML2	I have a passion to learn mathematics concepts	1	2	3	4	5
DML3	I critically evaluate new ideas	1	2	3	4	5
DML4	I like to evaluate what I do	1	2	3	4	5
DML5	I am open to new ideas	1	2	3	4	5
DML6	When presented with a problem I cannot resolve I always ask for assistance	1	2	3	4	5
SC	**Self-Control**					
SC1	I prefer to set my own learning goals	1	2	3	4	5
SC2	I like to make decisions for myself	1	2	3	4	5
SC3	I always set high personal standards	1	2	3	4	5
SC4	I evaluate my own performance	1	2	3	4	5
SC5	I can find out information for my self	1	2	3	4	5
SC6	I prefer to set my own criteria on which to evaluate my performance	1	2	3	4	5
MPU	**Moodle Perceived Usefulness**					
MPU1	Moodle helps me to learn more efficiently	1	2	3	4	5
MPU2	Moodle improves my academic performance	1	2	3	4	5
MPU3	Moodle makes my learning more effective	1	2	3	4	5
MPU4	Moodle makes it easier to learn at university	1	2	3	4	5
MPU5	Moodle gives me control over my learning	1	2	3	4	5
MPU6	Overall, Moodle is advantageous for my learning	1	2	3	4	5
MSE	**Moodle Self-Efficacy**					
MSE1	I can access the contents of Moodle	1	2	3	4	5
MSE2	I can freely navigate the contents of Moodle	1	2	3	4	5
MSE3	I can use Moodle without needing to be told how it functions	1	2	3	4	5
MSE4	I can solve problems that arise on Moodle	1	2	3	4	5
MSE5	I can use Moodle if there are user manuals available	1	2	3	4	5
MSE6	Overall, I can use Moodle	1	2	3	4	5
MPEU	**Moodle Perceived Ease of Use**					
MPEU1	Learning to use Moodle is easy for me	1	2	3	4	5
MPEU2	It is easy to get materials from Moodle	1	2	3	4	5

MPEU3	The process of using Moodle is clear and understandable	1	2	3	4	5
MPEU4	Overall, I believe that Moodle is easy to use	1	2	3	4	5
MAT	**Moodle Attitude**					
MAT1	Learning using Moodle is fun	1	2	3	4	5
MAT2	Using Moodle is a good idea	1	2	3	4	5
MAT3	Using Moodle is an attractive way to learn	1	2	3	4	5
MAT4	Overall, I like using Moodle	1	2	3	4	5

Appendix 6: The Moodle Self-Directed Learning with Technology Scale (MSDLTS) Questionnaire

The following is a bank of items perceived to reflect the attributes, skills and motivational factors required of self-directed learners when learning using Moodle. Please evaluate each item regarding the degree the item measures a characteristic of yourself. You are required to assess each item using a 5-point Likert scale as follows: Please put a cross on:

1. If you "strongly disagree" that the item measures the characteristic of yourself.
2. If you "disagree" that the item measures the characteristic of yourself.
3. If you "not sure" that the item measures the characteristic of yourself.
4. If you "agree" that the item measures the characteristic of yourself.
5. If you "strongly agree" that the item measures the characteristic of yourself.

Indicate your views on items below by circling the number. For each item there is a row of numbers (1 – 5) corresponding to a five-point scale. Choose only **one** response by **putting a cross on** only **one** of the numbers. The numbers stand for the following responses:

Item	**SD**	**D**	**NS**	**A**	**SA**
MSDLTS					
I use Moodle to ask my lecturer questions on my lessons when I am not in school.	1	2	3	4	5
I use Moodle to share my thoughts and ideas about my schoolwork	1	2	3	4	5
I find out more information on Moodle to help me understand my lessons better	1	2	3	4	5
I use Moodle to work with information for my learning.	1	2	3	4	5
I use Moodle to become better at a skill in which I am interested.	1	2	3	4	5
I use Moodle to get ideas from different websites and people to learn more about a topic.	1	2	3	4	5

Appendix 7: Logs analysis schedule

Course/Activity logs	Number of students	Total number of action logs	Average actions per student
Online Assignment	150		
Online Quiz	150		
Questions posted	150		
Discussion Forums	150		

Appendix 8: Interview Guide

After Moodle intervention, students will be interviewed individually to get their experiences and views on Moodle Mathematics self-directed learning. Questions like the following will be asked:

INTRODUCTION	**STEPS TAKEN**
	Welcome the student and discuss general well-being
	Recap to student what research is, including a summary of the research project and his/her role within the research
	Remind student that he/she will be recorded
	recap how anonymity will be assured
	Explain that student will receive a transcript to 'check' his/her responses
	Ask student if he/she has any question
INTERVIEW	**QUESTIONS**
	Lecturer: I would like you to share with me your views about Moodle Mathematics self-directed learning. Please tell me about your perceptions of Moodle in promoting mathematics self-directed learning? **Student**: …….
	Lecturer: Did you find the use of Moodle in Mathematics learning interesting or enjoyable? Student: …….
	Lecturer: Why do you say so? Tell me more. **Student**: …….
	Lecturer: Tell me about the degree of confidence that you had in learning Mathematics through Moodle. **Student**: …….
	Lecturer: After using Moodle, how do you perceive the improvement of your Mathematics self-directed skills? **Student**: …….
	Lecturer: How has Moodle helped to promote your Mathematics self-directed learning? **Student**: …….
	Lecturer: To what extent did Moodle help promote Mathematics independent and autonomous learning? **Student**: …….
	Lecturer: Can you explain further. Why do you say so? **Learner**: …….
	Lecturer: Tell me which challenges did you encounter in terms of Moodle mathematics teaching and learning? **Student**: …….
	Lecturer: Will you recommend the use of Moodle as a Learning Management System to promote Mathematics self-directed learning? **Student**: ……
	Lecturer: Why do you say so? **Student**: …….
	Lecturer: Thank you very much for your interesting views.
CONCLUSION	**STEPS**
	Explain that the interview has ended
	Invite the student to make any further comments
	Reassure the student about any aspects of the process, e.g., anonymity, reporting of findings, my role as researcher etc.
	Formally thank the student for his/her time, willingness to be involved and their answers.
	Remind the student that they will receive a copy of the transcript later and may wish to amend or clarify their responses

Pre Moodle Self-Directed Evaluation

Appendix A: Research questionnaire: demographic characteristics and internet experience

Surname and Initials: Vilakazi . NN Student number: 2019011 45

Instructions: Thank you for participating in this study. Please read all the instructions carefully and answer all the questions as honestly as you can, ensuring not to leave any questions unanswered. All information gathered will be kept anonymous and confidentiality is guaranteed. Your cooperation is greatly appreciated.

Please put a cross on one item per characteristic

DEMOGRAPHIC CHARACTERISTICS AND INTERNET EXPERIENCE		
Gender	Male	
	Female	X
Age	17-19 years	
	20-22 years	X
	More than 22 years	
Internet experience	No experience	X
	Some experience	
	Experienced	
	Very experienced	
Moodle experience	No experience	
	Some experience	X
	Experienced	
	Very experienced	
Do you have computer at home	Yes	
	No	X
How long have you been using computers	0 years	X
	1-3 years	
	3-6 years	
	More than 6 years	
What is your level of computer competency?	Nothing	X
	Beginner	
	Intermediate	
	Expert	
Do you have access to the Internet?	Yes	X
	No	
How long have you been using the Internet	0 years	
	1-3 years	X
	3-6 years	
	More than 6 years	
How much time do you often spend on the Internet in a day?	Less than 1 hour	
	1 – 4 hours	X
	More than 4 hours	
What is your level of experience with on-line courses?	Nothing	
	Beginner	X
	Intermediate	
	Expert	

Appendix B: Pre Intervention SDLRS items

Indicate your views on items below by circling the number. For each item there is a row of numbers (1 – 5) corresponding to a five point scale. Choose only **one** response by **putting a cross** only **one** of the numbers. The numbers stand for the following responses:

Strongly disagree	Disagree	Not agree and not disagree	Agree	Strongly agree
1	2	3	4	5

For example:
If you **strongly disagree** with the statement ***"I am self-disciplined."*** Then put a cross on number **1**

ITEM CODE	FACTOR SUB FACTOR ITEM	SD	MD	NAND	MA	SA
SM	**Self-Management**					
SM1	I am self-disciplined	1	2	3	4	5
SM2	I have good management skills	1	2	3	4	5
SM3	I set time frames for my study	1	2	3	4	5
SM4	I can be trusted to pursue my own learning	1	2	3	4	5
SM5	I prefer to plan my own learning	1	2	3	4	5
SM6	I am confident in my ability to search out information	1	2	3	4	5
DML	**Desire for Mathematics learning**					
DML1	I have a passion for Mathematics	1	2	3	4	5
DML2	I have a passion to learn mathematics concepts	1	2	3	4	5
DML3	I critically evaluate new ideas	1	2	3	4	5
DML4	I like to evaluate what I do	1	2	3	4	5
DML5	I am open to new ideas	1	2	3	4	5
DML6	When presented with a problem I cannot resolve I always ask for assistance	1	2	3	4	
SC	**Self-Control**					
SC1	I prefer to set my own learning goals	1	2	3	4	5
SC2	I like to make decisions for myself	1	2	3	4	5
SC3	I always set high personal standards	1	2	3	4	5
SC4	I evaluate my own performance	1	2	3	4	5
SC5	I can find out information for my self	1	2	3	4	5
SC6	I prefer to set my own criteria on which to evaluate my performance	1	2	3	4	5

Pre Moodle Self-Directed Evaluation

Appendix A: Research questionnaire: demographic characteristics and internet experience

Surname and Initials: Lupoko F.M Student number: 201728546

Instructions: Thank you for participating in this study. Please read all the instructions carefully and answer all the questions as honestly as you can, ensuring not to leave any questions unanswered. All information gathered will be kept anonymous and confidentiality is guaranteed. Your cooperation is greatly appreciated.

Please put a cross on one item per characteristic

DEMOGRAPHIC CHARACTERISTICS AND INTERNET EXPERIENCE		
Gender	Male	
	Female	X
Age	17-19 years	
	20-22 years	
	More than 22 years	X
Internet experience	No experience	
	Some experience	X
	Experienced	
	Very experienced	
Moodle experience	No experience	X
	Some experience	
	Experienced	
	Very experienced	
Do you have computer at home	Yes	
	No	X
How long have you been using computers	0 years	X
	1-3 years	
	3-6 years	
	More than 6 years	
What is your level of computer competency?	Nothing	
	Beginner	X
	Intermediate	
	Expert	
Do you have access to the Internet?	Yes	X
	No	
How long have you been using the Internet	0 years	
	1-3 years	X
	3-6 years	
	More than 6 years	
How much time do you often spend on the Internet in a day?	Less than 1 hour	
	1 – 4 hours	X
	More than 4 hours	
What is your level of experience with on-line courses?	Nothing	X
	Beginner	
	Intermediate	
	Expert	

Appendix B: Pre Intervention SDLRS items

Indicate your views on items below by circling the number. For each item there is a row of numbers (1 – 5) corresponding to a five point scale. Choose only **one** response by **putting a cross** only **one** of the numbers. The numbers stand for the following responses:

Strongly disagree	Disagree	Not agree and not disagree	Agree	Strongly agree
1	2	3	4	5

For example:
If you **strongly disagree** with the statement ***"I am self-disciplined."*** Then put a cross on number **1**

ITEM CODE	FACTOR SUB FACTOR ITEM	SD	MD	NAND	MA	SA
SM	**Self-Management**					
SM1	I am self-disciplined	1	2X	3	4	5
SM2	I have good management skills	1	2X	3	4	5
SM3	I set time frames for my study	1	2	3 X	4	5
SM4	I can be trusted to pursue my own learning	1	2	3 X	4	5
SM5	I prefer to plan my own learning	1	2	3 X	4	5
SM6	I am confident in my ability to search out information	1	2	3 X	4	5
DML	**Desire for Mathematics learning**					
DML1	I have a passion for Mathematics	1	2	3 X	4	5
DML2	I have a passion to learn mathematics concepts	1	2	3 X	4	5
DML3	I critically evaluate new ideas	1	2	3 X	4	5
DML4	I like to evaluate what I do	1	2	3 X	4	5
DML5	I am open to new ideas	1	2	3 X	4	5
DML6	When presented with a problem I cannot resolve I always ask for assistance	1	2 X	3	4	
SC	**Self-Control**					
SC1	I prefer to set my own learning goals	1	2	3 X	4	5
SC2	I like to make decisions for myself	1	2	3 X	4	5
SC3	I always set high personal standards	1	2X	3	4	5
SC4	I evaluate my own performance	1	2	3 X	4	5
SC5	I can find out information for my self	1	2X	3	4	5
SC6	I prefer to set my own criteria on which to evaluate my performance	1	2 X	3	4	5

Pre Moodle Self-Directed Evaluation

Appendix A: Research questionnaire: demographic characteristics and internet experience

Surname and Initials: NDLOVU M.S.I Student number: 201958588

Instructions: Thank you for participating in this study. Please read all the instructions carefully and answer all the questions as honestly as you can, ensuring not to leave any questions unanswered. All information gathered will be kept anonymous and confidentiality is guaranteed. Your cooperation is greatly appreciated.

Please put a cross on one item per characteristic

DEMOGRAPHIC CHARACTERISTICS AND INTERNET EXPERIENCE		
Gender	Male	X
	Female	
Age	17-19 years	X
	20-22 years	
	More than 22 years	
Internet experience	No experience	
	Some experience	X
	Experienced	
	Very experienced	
Moodle experience	No experience	
	Some experience	X
	Experienced	
	Very experienced	
Do you have computer at home	Yes	
	No	X
How long have you been using computers	0 years	X
	1-3 years	
	3-6 years	
	More than 6 years	
What is your level of computer competency?	Nothing	
	Beginner	X
	Intermediate	
	Expert	
Do you have access to the Internet?	Yes	
	No	X
How long have you been using the Internet	0 years	X
	1-3 years	
	3-6 years	
	More than 6 years	
How much time do you often spend on the Internet in a day?	Less than 1 hour	X
	1 – 4 hours	
	More than 4 hours	
What is your level of experience with on-line courses?	Nothing	
	Beginner	X
	Intermediate	
	Expert	

Appendix B: Pre Intervention SDLRS items

Indicate your views on items below by circling the number. For each item there is a row of numbers (1 – 5) corresponding to a five point scale. Choose only **one** response by **putting a cross** only **one** of the numbers. The numbers stand for the following responses:

Strongly disagree	Disagree	Not agree and not disagree	Agree	Strongly agree
1	2	3	4	5

For example:
If you **strongly disagree** with the statement ***"I am self-disciplined."*** Then put a cross on number **1**

ITEM CODE	FACTOR SUB FACTOR ITEM	SD	MD	NAND	MA	SA
SM	**Self-Management**					
SM1	I am self-disciplined	1	2	3 X	4	5
SM2	I have good management skills	1	2	3 X	4	5
SM3	I set time frames for my study	1	2	3 X	4	5
SM4	I can be trusted to pursue my own learning	1	2	3 X	4	5
SM5	I prefer to plan my own learning	1	2	3 X	4	5
SM6	I am confident in my ability to search out information	1	2	3 X	4	5
DML	**Desire for Mathematics learning**					
DML1	I have a passion for Mathematics	1 X	2	3	4	5
DML2	I have a passion to learn mathematics concepts	1	2 X	3	4	5
DML3	I critically evaluate new ideas	1	2	3 X	4	5
DML4	I like to evaluate what I do	1	2	3 X	4	5
DML5	I am open to new ideas	1	2	3 X	4	5
DML6	When presented with a problem I cannot resolve I always ask for assistance	1	2	3 X	4	
SC	**Self-Control**					
SC1	I prefer to set my own learning goals	1	2	3 X	4	5
SC2	I like to make decisions for myself	1	2	3 X	4	5
SC3	I always set high personal standards	1	2	3 X	4	5
SC4	I evaluate my own performance	1	2	3 X	4	5
SC5	I can find out information for my self	1	2	3 X	4	5
SC6	I prefer to set my own criteria on which to evaluate my performance	1	2 X	3	4	5

Appendix 5: Post Evaluation SDLRS-SPQ Questionnaire

The following is a bank of items perceived to reflect the attributes, skills and motivational factors required of self-directed learners. Please evaluate each item regarding the degree the item measures a characteristic of yourself. You are required to assess each item using a 5 point Likert scale as follows: Please put a cross on:

1. If you "strongly disagree" that the item measures the characteristic of yourself.
2. If you "disagree" that the item measures the characteristic of yourself.
3. If you "not sure" that the item measures the characteristic of yourself.
4. If you "agree" that the item measures the characteristic of yourself.
5. If you "strongly agree" that the item measures the characteristic of yourself.

ITEM CODE	FACTOR SUB FACTOR ITEM	SD	D	NS	A	SA
SM	**Self Management**					
SM1	I am self-disciplined	1	2	3	4	5X
SM2	I have good management skills	1	2	3	4	5 X
SM3	I set time frames for my study	1	2	3	4 X	5
SM4	I can be trusted to pursue my own learning	1	2	3	4 x	5
SM5	I prefer to plan my own learning	1	2	3	4 x	5
SM6	I am confident in my ability to search out information	1	2	3	4 x	5
DML	**Desire for Mathematical Learning**					
DML1	I have a passion for Mathematics	1	2	3	4 x	5
DML2	I have a passion to learn mathematics concepts	1	2	3	4 x	5
DML3	I critically evaluate new ideas	1	2	3	4 x	5
DML4	I like to evaluate what I do	1	2	3	4 x	5
DML5	I am open to new ideas	1	2	3	4 x	5
DML6	When presented with a problem I cannot resolve I always ask for assistance	1	2	3	4 x	5
SC	**Self Control**					
SC1	I prefer to set my own learning goals	1	2	3	4 x	5
SC2	I like to make decisions for myself	1	2	3	4 x	5
SC3	I always set high personal standards	1	2	3	4 x	5
SC4	I evaluate my own performance	1	2	3	4 x	5
SC5	I can find out information for my self	1	2	3	4 x	5
SC6	I prefer to set my own criteria on which to evaluate my performance	1	2	3	4 x	5
MPU	**Moodle Perceived Usefulness**					
MPU1	Moodle helps me to learn more efficiently	1	2	3	4 x	5
MPU2	Moodle improves my academic performance	1	2	3	4 x	5
MPU3	Moodle makes my learning more effective	1	2	3	4 x	5
MPU4	Moodle makes it easier to learn at university	1	2	3	4 x	5
MPU5	Moodle gives me control over my learning	1	2	3	4 x	5
MPU6	Overall, Moodle is advantageous for my learning	1	2	3	4 x	5
MSE	**Moodle Self-Efficacy**					
MSE1	I can access the contents of Moodle	1	2	3	4 x	5
MSE2	I can freely navigate the contents of Moodle	1	2	3	4	5 x
MSE3	I can use Moodle without needing to be told how it functions	1	2	3	4	5 X
MSE4	I can solve problems that arise on Moodle	1	2	3	4	5 X
MSE5	I can use Moodle if there are user manuals available	1	2	3	4 X	5
MSE6	Overall, I am able to use Moodle	1	2	3	4	5 X
MPEU	**Moodle Perceived Ease of Use**					
MPEU1	Learning to use Moodle is easy for me	1	2	3	4	5X
MPEU2	It is easy to get materials from Moodle	1	2	3	4 X	5
MPEU3	The process of using Moodle is clear and understandable	1	2	3	4	5 X
MPEU4	Overall, I believe that Moodle is easy to use	1	2	3	4	5 X
MAT	**Moodle Attitude**					
MAT1	Learning using Moodle is fun	1	2	3	4 X	5
MAT2	Using Moodle is a good idea	1	2	3	4	5 X
MAT3	Using Moodle is an attractive way to learn	1	2	3	4	5 X
MAT4	Overall, I like using Moodle	1	2	3	4	5 X

Appendix 5: Post Evaluation SDLRS-SPQ Questionnaire

The following is a bank of items perceived to reflect the attributes, skills and motivational factors required of self-directed learners. Please evaluate each item regarding the degree the item measures a characteristic of yourself. You are required to assess each item using a 5 point Likert scale as follows: Please put a cross on:

1. If you "strongly disagree" that the item measures the characteristic of yourself.
2. If you "disagree" that the item measures the characteristic of yourself.
3. If you "not sure" that the item measures the characteristic of yourself.
4. If you "agree" that the item measures the characteristic of yourself.
5. If you "strongly agree" that the item measures the characteristic of yourself.

ITEM CODE	FACTOR / SUB FACTOR ITEM	SD	D	NS	A	SA
SM	**Self Management**					
SM1	I am self-disciplined	1	2	3	4	5X
SM2	I have good management skills	1	2	3	4	5X
SM3	I set time frames for my study	1	2	3	4X	5
SM4	I can be trusted to pursue my own learning	1	2	3	4	5X
SM5	I prefer to plan my own learning	1	2	3	4X	5
SM6	I am confident in my ability to search out information	1	2	3	4X	5
DML	**Desire for Mathematical Learning**					
DML1	I have a passion for Mathematics	1	2	3	4X	5
DML2	I have a passion to learn mathematics concepts	1	2	3	4	5X
DML3	I critically evaluate new ideas	1	2	3	4X	5
DML4	I like to evaluate what I do	1	2	3	4	5X
DML5	I am open to new ideas	1	2	3	4X	5
DML6	When presented with a problem I cannot resolve I always ask for assistance	1	2	3	4	5X
SC	**Self Control**					
SC1	I prefer to set my own learning goals	1	2	3	4	5X
SC2	I like to make decisions for myself	1	2	3	4	5X
SC3	I always set high personal standards	1	2	3	4	5X
SC4	I evaluate my own performance	1	2	3	4	5X
SC5	I can find out information for my self	1	2	3	4	5X
SC6	I prefer to set my own criteria on which to evaluate my performance	1	2	3	4	5X
MPU	**Moodle Perceived Usefulness**					
MPU1	Moodle helps me to learn more efficiently	1	2	3	4	5X
MPU2	Moodle improves my academic performance	1	2	3	4X	5
MPU3	Moodle makes my learning more effective	1	2	3	4X	5
MPU4	Moodle makes it easier to learn at university	1	2	3	4	5X
MPU5	Moodle gives me control over my learning	1	2	3	4	5X
MPU6	Overall, Moodle is advantageous for my learning	1	2	3	4	5X
MSE	**Moodle Self-Efficacy**					
MSE1	I can access the contents of Moodle	1	2	3	4X	5
MSE2	I can freely navigate the contents of Moodle	1	2	3	4X	5
MSE3	I can use Moodle without needing to be told how it functions	1	2	3	4X	5X
MSE4	I can solve problems that arise on Moodle	1	2	3	4	5X
MSE5	I can use Moodle if there are user manuals available	1	2	3	4	5X
MSE6	Overall, I am able to use Moodle	1	2	3	4	5X
MPEU	**Moodle Perceived Ease of Use**					
MPEU1	Learning to use Moodle is easy for me	1	2	3	4	5X
MPEU2	It is easy to get materials from Moodle	1	2	3	4	5X
MPEU3	The process of using Moodle is clear and understandable	1	2	3	4X	5
MPEU4	Overall, I believe that Moodle is easy to use	1	2	3	4X	5
MAT	**Moodle Attitude**					
MAT1	Learning using Moodle is fun	1	2	3	4	5X
MAT2	Using Moodle is a good idea	1	2	3	4X	5
MAT3	Using Moodle is an attractive way to learn	1	2	3	4	5X
MAT4	Overall, I like using Moodle	1	2	3	4	5X

Appendix 5: Post Evaluation SDLRS-SPQ Questionnaire

The following is a bank of items perceived to reflect the attributes, skills and motivational factors required of self-directed learners. Please evaluate each item regarding the degree the item measures a characteristic of yourself. You are required to assess each item using a 5 point Likert scale as follows: Please put a cross on:

1. If you "strongly disagree" that the item measures the characteristic of yourself.
2. If you "disagree" that the item measures the characteristic of yourself.
3. If you "not sure" that the item measures the characteristic of yourself.
4. If you "agree" that the item measures the characteristic of yourself.
5. If you "strongly agree" that the item measures the characteristic of yourself.

ITEM CODE	FACTOR SUB FACTOR ITEM	SD	D	NS	A	SA
SM	**Self Management**					
SM1	I am self-disciplined	1	2	3	4	5
SM2	I have good management skills	1	2	3	4	5
SM3	I set time frames for my study	1	2	3	4	5
SM4	I can be trusted to pursue my own learning	1	2	3	4	5
SM5	I prefer to plan my own learning	1	2	3	4	5
SM6	I am confident in my ability to search out information	1	2	3	4	5
DML	**Desire for Mathematical Learning**					
DML1	I have a passion for Mathematics	1	2	3	4	5
DML2	I have a passion to learn mathematics concepts	1	2	3	4	5
DML3	I critically evaluate new ideas	1	2	3	4	5
DML4	I like to evaluate what I do	1	2	3	4	5
DML5	I am open to new ideas	1	2	3	4	5
DML6	When presented with a problem I cannot resolve I always ask for assistance	1	2	3	4	5
SC	**Self Control**					
SC1	I prefer to set my own learning goals	1	2	3	4	5
SC2	I like to make decisions for myself	1	2	3	4	5
SC3	I always set high personal standards	1	2	3	4	5
SC4	I evaluate my own performance	1	2	3	4	5
SC5	I can find out information for my self	1	2	3	4	5
SC6	I prefer to set my own criteria on which to evaluate my performance	1	2	3	4	5
MPU	**Moodle Perceived Usefulness**					
MPU1	Moodle helps me to learn more efficiently	1	2	3	4	5
MPU2	Moodle improves my academic performance	1	2	3	4	5
MPU3	Moodle makes my learning more effective	1	2	3	4	5
MPU4	Moodle makes it easier to learn at university	1	2	3	4	5
MPU5	Moodle gives me control over my learning	1	2	3	4	5
MPU6	Overall, Moodle is advantageous for my learning	1	2	3	4	5
MSE	**Moodle Self-Efficacy**					
MSE1	I can access the contents of Moodle	1	2	3	4	5
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MSE3	I can use Moodle without needing to be told how it functions	1	2	3	4	5
MSE4	I can solve problems that arise on Moodle	1	2	3	4	5
MSE5	I can use Moodle if there are user manuals available	1	2	3	4	5
MSE6	Overall, I am able to use Moodle	1	2	3	4	5
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MPEU3	The process of using Moodle is clear and understandable	1	2	3	4	5
MPEU4	Overall, I believe that Moodle is easy to use	1	2	3	4	5
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MAT1	Learning using Moodle is fun	1	2	3	4	5
MAT2	Using Moodle is a good idea	1	2	3	4	5
MAT3	Using Moodle is an attractive way to learn	1	2	3	4	5
MAT4	Overall, I like using Moodle	1	2	3	4	5

Appendix 6: The Moodle Self-Directed Learning with Technology Scale (MSDLTS) Questionnaire

The following is a bank of items perceived to reflect the attributes, skills and motivational factors required of self-directed learners when learning using Moodle. Please evaluate each item regarding the degree the item measures a characteristic of yourself. You are required to assess each item using a 5 point Likert scale as follows: Please put a cross on:

1. If you "strongly disagree" that the item measures the characteristic of yourself.
2. If you "disagree" that the item measures the characteristic of yourself.
3. If you "not sure" that the item measures the characteristic of yourself.
4. If you "agree" that the item measures the characteristic of yourself.
5. If you "strongly agree" that the item measures the characteristic of yourself.

Indicate your views on items below by circling the number. For each item there is a row of numbers (1 – 5) corresponding to a five point scale. Choose only **one** response by **putting a cross on** only **one** of the numbers. The numbers stand for the following responses:

Item	SD	D	NS	A	SA
MSDLTS					
I use Moodle to ask my lecturer questions on my lessons when I am not in school.	1	2	3	4X	5
I use Moodle to share my thoughts and ideas about my schoolwork	1	2	3	4	5X
I find out more information on Moodle to help me understand my lessons better	1	2	3	4	5X
I use Moodle to work with information for my learning.	1	2	3	4X	5
I use Moodle to become better at a skill that I am interested in.	1	2	3	4X	5
I use Moodle to get ideas from different websites and people to learn more about a topic.	1	2	3	4X	5

Appendix 6: The Moodle Self-Directed Learning with Technology Scale (MSDLTS) Questionnaire

The following is a bank of items perceived to reflect the attributes, skills and motivational factors required of self-directed learners when learning using Moodle. Please evaluate each item regarding the degree the item measures a characteristic of yourself. You are required to assess each item using a 5 point Likert scale as follows: Please put a cross on:

1. If you "strongly disagree" that the item measures the characteristic of yourself.
2. If you "disagree" that the item measures the characteristic of yourself.
3. If you "not sure" that the item measures the characteristic of yourself.
4. If you "agree" that the item measures the characteristic of yourself.
5. If you "strongly agree" that the item measures the characteristic of yourself.

Indicate your views on items below by circling the number. For each item there is a row of numbers (1 – 5) corresponding to a five point scale. Choose only **one** response by **putting a cross on** only **one** of the numbers. The numbers stand for the following responses:

Item	SD	D	NS	A	SA
MSDLTS					
I use Moodle to ask my lecturer questions on my lessons when I am not in school.	1	2	3	4 X	5
I use Moodle to share my thoughts and ideas about my schoolwork	1	2	3	4 X	5
I find out more information on Moodle to help me understand my lessons better	1	2	3	4	5 X
I use Moodle to work with information for my learning.	1	2	3	4	5 X
I use Moodle to become better at a skill that I am interested in.	1	2	3	4	5 X
I use Moodle to get ideas from different websites and people to learn more about a topic.	1	2	3	4 X	5

Appendix 6: The Moodle Self-Directed Learning with Technology Scale (MSDLTS) Questionnaire

The following is a bank of items perceived to reflect the attributes, skills and motivational factors required of self-directed learners when learning using Moodle. Please evaluate each item regarding the degree the item measures a characteristic of yourself. You are required to assess each item using a 5 point Likert scale as follows: Please put a cross on:

1. If you "strongly disagree" that the item measures the characteristic of yourself.
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4. If you "agree" that the item measures the characteristic of yourself.
5. If you "strongly agree" that the item measures the characteristic of yourself.

Indicate your views on items below by circling the number. For each item there is a row of numbers (1 – 5) corresponding to a five point scale. Choose only **one** response by **putting a cross on** only **one** of the numbers. The numbers stand for the following responses:

Item	SD	D	NS	A	SA
MSDLTS					
I use Moodle to ask my lecturer questions on my lessons when I am not in school.	1	2	3	4 X	5
I use Moodle to share my thoughts and ideas about my schoolwork	1	2	3	4 X	5
I find out more information on Moodle to help me understand my lessons better	1	2	3	4	5 X
I use Moodle to work with information for my learning.	1	2	3	4	5 X
I use Moodle to become better at a skill that I am interested in.	1	2	3	4	5 X
I use Moodle to get ideas from different websites and people to learn more about a topic.	1	2	3	4 X	5

INTERVIEW TRANSCRIPTS

INTRODUCTION **Lecturer:** Let me take this opportunity to welcome you to this interview session. How are you? **Student:** I and fine. **Lecturer:** Let me first thank you for participating in this interview. This interview is based on the research study titled "THE INVESTIGATION OF THE STUDENTS' PERSPECTIVES ON MOODLE IN PROMOTING MATHEMATICS SELF-DIRECTED LEARNING". Let me first explain you what research is. Research is a systematic investigation undertaken in order to discover new facts, get additional information. It is something that people undertake to find out new things in a systematic way, thereby increasing their knowledge. It is a process of steps used to collect and analyse information to increase our understanding of a topic or issue research adds to our knowledge. This study investigates the students' perspectives on Moodle in promoting mathematics self-directed learning. This is because research indicates that most students who are admitted at universities are underprepared in terms of self-directed learning. Your role as a participant in this interview is to answer questions based on your views regarding the effect of Moodle in promoting Mathematics self-directed learning. Take note that this interview will be recorded. No real names would be used in the write-up and presentations of results, rather pseudonyms would be used. You will receive the transcript of the interview to check your responses **Lecturer: Do you have any question?** **Student: No, I do not have.**
INTERVIEW
Lecturer: I would like you to share with me your views about Moodle Mathematics self-directed learning. Please tell me about your perceptions of Moodle in promoting mathematics self-directed learning? **Student**: For me Moodle is good in promoting self-directed learning. This is because in all lessons are uploaded in Moodle. I am able to do my tasks at my own pace, place and time.
Lecturer: Did you find the use of Moodle in Mathematics learning interesting or enjoyable? **Student**: Yes. I find the use of Moodle in Mathematics learning enjoyable. Moodle learning helps me to learn more than I used to learn in the classroom because I can study anywhere.
Lecturer: Why do you say so? Tell me more. **Student**: This is because with Moodle, I am able to access tasks given to me anytime and even when I am not in class. I am able to submit tasks anytime. I do not have to be in class to submit tasks.
Lecturer: Tell me about the degree of confidence that you had in learning Mathematics through Moodle. **Student**: I do not know how to explain it. What I can say is that I always interact with other students using chat. If I am afraid to ask a question in class, I can ask the lecturer or other friends through the chat session. Chat sessions are helpful because they stimulate me to ask questions.
Lecturer: After using Moodle, how do you perceive the improvement of your Mathematics self-directed skills? **Student**: For me, Moodle helped me to always check which tasks are due and then plan the timetable of my submission. I am able to study the tasks uploaded on Moodle and work on my own time.

Lecturer: How has Moodle helped to promote your Mathematics self-directed learning?
Student: Moodle has helped me to monitor my own learning. With Moodle learning, I have learnt to evaluate my own work. I recheck the problem and evaluate the problem and solution.
Lecturer: To what extent did Moodle help promote Mathematics independent and autonomous learning? **Student**: My learning is now flexible
Lecturer: Can you explain further. Why do you say so? **Student**: Moodle increases my sense of responsibility. I now have to manage my learning. For example I now manage the due dates of submitting tasks and attending classes.
Lecturer: Tell me which challenges did you encounter in terms of Moodle mathematics teaching and learning? **Student**: For the lack of laptop was a problem. I mostly relied on my phone which is not of good quality. I mostly relied on my friend's laptop and the ones in the computer labs. The internet connection was a problem. Sometimes the internet connection was bad.
Lecturer: Will you recommend the use of Moodle as a Learning Management System to promote Mathematics self-directed learning? **Student**: Yes.
Lecturer: Why? **Student**: What I like about Moodle is I am able to write test anywhere anytime and and be able to submit assignments on it. When we write quizzes, we get instant feedback. This is good for us because you immediately get feedback and correct your mistakes. We do not wait for days to get feedback. In Moodle you are able to interact with other students using chat room/discussion. Let us say you are sick, and you are not able to attend class, with Moodle you may submit tasks at home. The lecturer is able to upload video lessons. Students are able to access these videos at their own time.
Lecturer: Thank you very much for your interesting views.
CONCLUSION
We have come to the end of the interview session. Thank you very much for participating in this interview. Your willingness to answer the questions will contribute to the body of knowledge in terms of self-directed learning. You will receive a receive a copy of the transcript at a later date.

INTRODUCTION

Lecturer: Let me take this opportunity to welcome you to this interview session. How are you?

Student: I am fine and how are you sir?

Lecturer: I am also fine. Thank you for agreeing to participate in this interview.

This interview is based on the research study titled "THE INVESTIGATION OF THE STUDENTS' PERSPECTIVES ON MOODLE IN PROMOTING MATHEMATICS SELF-DIRECTED LEARNING".

Let me first explain you what research is. Research is a systematic investigation undertaken in order to discover new facts and get additional information. It is something that people undertake to find out new things in a systematic way, thereby increasing their knowledge. It is a process of steps used to collect and analyse information to increase our understanding of a topic or issue research adds to our knowledge.

This study investigates the students' perspectives on Moodle in promoting mathematics self-directed learning. This is because research indicates that most students who are admitted at universities are underprepared in terms of self-directed learning. Your role as a participant in this interview is to answer questions based on your views regarding the effect of Moodle in promoting Mathematics self-directed learning.

Take note that this interview will be recorded. No real names would be used in the write-up and presentations of results, rather, pseudonyms would be used. You will receive the transcript of the interview to check your responses

Do you have any question?

Student: No. I do not have a question.

INTERVIEW

Lecturer: I would like you to share with me your views about Moodle Mathematics self-directed learning. Please tell me about your perceptions of Moodle in promoting mathematics self-directed learning?

Student: I think Moodle is good. Moodle gives students to study while at home. They can get materials on Moodle and study on their own, at their own time.

Lecturer: Did you find the use of Moodle in Mathematics learning interesting or enjoyable?

Student: Yes learning with Moodle is enjoyable.

Lecturer: Why do you say so? Tell me more.

Student: With Moodle, I know that even when I miss a class, the lecturer always uploads lessons on the platform. We sometimes write online assessments. This is good because even when I am noy at school I am still able to write tests.

Lecturer: Tell me about the degree of confidence that you had in learning Mathematics through Moodle.

Student: Moodle helped me to be active in seeking out information and assistance from my fellow students, as opposed to waiting for direction from the lecturer.

Lecturer: After using Moodle, how do you perceive the improvement of your Mathematics self-directed skills?

Student: I developed a sense of autonomy in the learning process. We are given mathematics module outlines and other materials by the lecturer. I am actually able to go through the whole module outlined on my own and be able to complete tasks independently.

Lecturer: How has Moodle helped to promote your Mathematics self-directed learning?

Student: My confidence in learning mathematics has had increased. Moodle has helped me to improve my confidence when I am communicating with others.

Lecturer: To what extent did Moodle help promote Mathematics independent and autonomous learning? **Student**: Moodle has made me to become more active in learning and do not just depend on the lecturer
Lecturer: Can you explain further. Why do you say so? **Student**: My confidence in learning mathematics has had increased. Moodle has helped me to improve my self-esteem when I am communicating with others
Lecturer: Tell me which challenges did you encounter in terms of Moodle mathematics teaching and learning? **Student**: Lack of data. This sometimes give me a challenge when I want to access study material. Where I stay there is a challenge of internet connectivity.
Lecturer: Will you recommend the use of Moodle as a Learning Management System to promote Mathematics self-directed learning? **Student**: Yes
Lecturer: Why do you say so? **Student**: This is because now most lessons are being conducted online. There are sometimes strikes which prevents learning in the campus. Even when you are sick or you are not on campus, you can still access learning materials on Moodle.
Lecturer: This is good. Thank you very much for your interesting views.
CONCLUSION
We have come to the end of the interview session. You are welcome to ask or comment on any issue pertaining this interview. Thank you very much for participating in this interview. Your willingness to answer the questions will contribute to the body of knowledge in terms of self-directed learning. You will receive a receive a copy of the transcript at a later date.

INTRODUCTION Lecturer: Let me take this opportunity to welcome you in this interview session. How are you? **Student**: I am fine, thanks sir. **Lecturer**: Before we start with the interview, Iwant to thank you for participating in this interview. This interview is based on the research study titled "THE INVESTIGATION OF THE STUDENTS' PERSPECTIVES ON MOODLE IN PROMOTING MATHEMATICS SELF-DIRECTED LEARNING". Let me first explain you what research is. Research is a systematic investigation undertaken to discover new facts, get additional information. It is something that people undertake in order to find out new things in a systematic way, thereby increasing their knowledge. It is a process of steps used to collect and analyse information to increase our understanding of a topic or issue research adds to our knowledge. This study investigates the students' perspectives on Moodle in promoting mathematics self-directed learning. This is because research indicates that most students who are admitted at universities are underprepared in terms of self-directed learning. Your role as a participant in this interview is to answer questions based on your views regarding the effect of Moodle in promoting Mathematics self-directed learning. Take note that this interview will be recorded. No real names would be used in the write-up and presentations of results, rather, pseudonyms would be used. You will receive the transcript of the interview to check your responses. Do you have any question? Student: No sir.

INTERVIEW
Lecturer: I would like you to share with me your views about Moodle Mathematics self-directed learning. Please tell me about your perceptions of Moodle in promoting mathematics self-directed learning? **Student**:
Lecturer: Did you find the use of Moodle in Mathematics learning interesting or enjoyable? Student: The way the lecturer has set the module is easy, practical and efficient. It easy to navigate around the Moodle platform. Moodle class had taught me the importance of planning in order to complete a task or solve a problem successfully: "Without Moodle I used to just do things without first thinking about that
Lecturer: Why do you say so? Tell me more. **Student**: What we are being taught is uploaded on Moodle in chapters. There is a section for quizzes, assignments, and tests. Announcements are being made on Moodle. It is easy to access information on Moodle.
Lecturer: Tell me about the degree of confidence that you had in learning Mathematics through Moodle. **Student**: Moodle has made me to be more enthusiastic to learn the mathematics. It has made me to become more active in learning and do not just depend on the lecturer. What I like about Moodle is that I am now able work independently. I preferred the Moodle online class. It was like on your own, not at your own pace, but like do-it-yourself.
Lecturer: After using Moodle, how do you perceive the improvement of your Mathematics self-directed skills?
Student: I have developed the confidence to study on my own. I am now able to plan my own study timetable. I download study materials, save them in folders and be able to read at my own time and pace.
Lecturer: How has Moodle helped to promote your Mathematics self-directed learning?
Student: My learning is now flexible. I am able to do my tasks at my own pace, place and time.
Lecturer: To what extent did Moodle helped promotes Mathematics independent and autonomous learning? **Student**: Moodle increases my sense of responsibility
Lecturer: Can you explain further. Why do you say so? **Student**: In Moodle I am able to download materials, check course updates and announcements, submit tasks. Moodle has helped to gain confidence in my studies because I am now able to study independently without being forced. If I have a problem, I just send a chat message to the lecturer or my friends.
Lecturer: Tell me which challenges did you encounter in terms of Moodle mathematics teaching and learning? **Student**: The lack of my lecturer, his physical presence in class. Sometimes it is frustrating to work on your own without the physical presence of the lecturer. I also experience challenges when submitting quizzes. You are given a time frame and when you are busy, the electricity will go off. This was a problem. Or while you are busy you find that you have run out of data.
Lecturer: Will you recommend the use of Moodle as a Learning Management System to promote Mathematics self-directed learning? **Student**: Yes, I will.
Lecturer: Why do you say so? **Student**: This is because with Moodle students are able to submit their tasks online without being in the class. Even when you are sick or absent from school you are still able to submit. You are also able to ask questions anytime. You can even chat to other students.
Lecturer: Thank you very much for your interesting views.

CONCLUSION
We have come to the end of the interview session. Thank you very much for participating in this interview. Your willingness to answer the questions will contribute to the body of knowledge in terms of self-directed learning. You will receive a copy of the transcript later.