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TOWARDS A FACILITATION FRAMEWORK FOR EFFECTIVE LEARNING AND TEACHING FOR FIRST-YEAR STUDENTS IN THE BUILDING MEASUREMENT MODULE

by

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Thesis (PhD)

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requirements for the Degree of
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Declaration Doctoral Student

I, **MART-MARI ELS** (Student number: 2004016669), with the title **“Towards a facilitation framework for effective learning and teaching for first-year students in the Building Measurement Module”** declare that the thesis that I herewith submit for the Doctoral Degree in Higher Education Studies in the School of Higher Education Faculty of Education at the University of the Free State, is my independent work and that I have not previously submitted it for a qualification at another institution of higher education.

2 July 2024

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Abstract

The purpose of this study is twofold. First, it aims to identify the pedagogical challenges faced by first-year students and lecturers in the building measurement module in South African universities. Second, it seeks to investigate the constructivist teaching approach, with a particular focus on the applicability of Vygotsky's theory of sociocultural development, as a potential solution to these challenges.

As such this study employed two separate but complementary research designs. Due to the limited contextual knowledge in the learning and teaching environment of first-year students in the building measurement module, it is essential to investigate and establish the challenges they face, as there is currently very little information available on this topic. The second methodology examines and proposes a potential solution to these challenges. The chosen research designs for this study are a convergent mixed-methods approach and a case-study design.

Data collected through a baseline survey, focus-group discussions, and semi-structured interviews in the first methodology informed the case-study design. In this case study, data from pre- and post-tests, participant observations, and reflections yielded significant results. The first methodology identified various challenges faced by first-year students and lecturers in the building measurement module. These challenges were then addressed and tested in the second methodology.

The findings of the research suggest that a constructivist teaching approach, more specifically Vygotsky's theory of sociocultural development are successful and can be applied through a facilitation framework. The value of this research study is the enhancement of first-year learning and teaching experience in Quantity Surveying Education.

Keywords: Building Measurement Module; Constructivism; First-Year Students; Higher Education; Quantity Surveying**;** Quantity Surveying Education; Underpreparedness; Vygotksy

Acknowledgments and Gratitude

Prayer of gratitude

> *Dear Heavenly Father, thank you for this journey. Thank you for the dream and passion you've placed in my heart. Thank you for your daily grace and promise to make it happen in your time. Thank you for allowing people to cross my path on this journey. Thank you for every lesson and opportunity. Please help me to fulfil my purpose and live every day to your glory. Amen.*

Special thanks to the following people who have contributed significantly to my journey and made a difference in my life. I am forever grateful.

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"Never think that success is down to your own performance alone … the flowers of victory belong in many vases."

-Michael Schumacher-

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CHAPTER 1

INTRODUCTION AND PROBLEM SETTING

1.1 INTRODUCTION

This chapter presents the broad context of the research and the basis for undertaking this doctoral study. The chapter gives an overview of the construction industry globally and locally and the quantity surveying profession functioning within this environment (see section 1.2). An overview of the learning and teaching in the built environment within the higher education (see section 1.2.1) context globally, and in South Africa in particular, is presented in this chapter. It further explores the challenges experienced in the learning and teaching of construction education (see section 1.2.2) specifically, in quantity surveying education, challenges are experienced in the building measurement module, with particular reference to first-year students, this module, building measurement, is one of the core modules in quantity surveying curriculums (see section 1.3). The quantification process, commonly referred to as "taking-off," involves measuring or scaling dimensions from construction drawings. These measurements are then recorded on dimension paper, or "dim-sheets" (Cunningham, 2014a; Lee, 2013). Furthermore, in this chapter, the research problem is identified, contextualised and presented; the theoretical framework for this study is presented; and the research questions are formulated and presented together with an overview of the research aim and objectives. In the last section of this chapter, an outline of the selected research methodologies and the ethical considerations are presented, and the structure and layout of the thesis are provided before the chapter summary is provided.

1.2 BACKGROUND TO THE STUDY

The construction industry is complex; there are multiple cooperative levels and stages of production that create the end product. The construction industry is an essential sector that includes manufacturing and trade activities focused on building, repairing, renovating, and maintaining infrastructure (Hussain, Paulraj & Nuzhat, 2022). Construction outputs can be categorized into 1) housing, 2) infrastructure, 3) industrial and commercial buildings, and 4) repair and maintenance (Pheng & Hou, 2019; Foulkes & Ruddock, 2007). The significance of the construction industry is reflected through the provisioning of shelter, infrastructure, and employment, which are vital to achieving socio-economic and developmental goals. Thus, the construction industry's performance and a country's economy are interlinked (Ayarkwa, Dansoh, Adinyira & Amoah, 2011).

As one of the largest consumers of raw materials, the construction industry significantly impacts both quality of life and economic vitality. Accounting for approximately 6% of the global gross domestic product (GDP), 7% of total employment, and a staggering 40% of global energy consumption, its impact reverberates throughout various sectors (PWC, 2016; World Economic Forum, 2016;). This impact manifests across three critical economic segments: the utilization and extraction of natural resources, the manufacturing of building materials, and the provision of consultancy services encompassing architecture, engineering, quantity surveying, and project management (Pheng & Hou, 2019).

In South Africa, the construction industry is also a significant contributor to economic growth and employment, whereby between 2009 and 2019, the industry created over 187 000 new jobs, and in 2020, the sector employed roughly 1,3 million people (Zingoni, 2020). The industry's outlook seemed promising, particularly with the government's plans to improve building and construction infrastructure (PWC, 2016; CIDB, 2019). Unfortunately, despite the positive outlook, the construction industry has shown a decline since 2017 and has contracted by 3,3% in 2019. With the negative impact of the COVID-19 pandemic on the industry since March 2020, it is predicted that the industry will contract even further (Research and Markets, 2020). Despite the pessimism, a positive outlook is forecasted and a growth of 5% is predicted for 2023 until 2027 in the construction industry (Research and Markets, 2023).

Many skilled professionals in the construction industry provide relevant and essential services, such as architects, engineers, land surveyors, town and regional planners, construction managers, project managers and quantity surveyors (Pheng & Hou, 2019). In addition to these professionals, Hauptfleisch and Sigle (2014) add that landscape architects, property valuers and facilities managers also form part of the professional consultant cohort serving in the built environment.

This study places particular emphasis on the role of quantity surveyors within the construction industry. These professionals serve as specialists in cost and value, offering expertise in advising clients on the financial implications of design choices and overseeing and managing construction expenses (Ashworth, Hogg & Higgs, 2013). Moreover, quantity surveyors provide a wide array of services throughout the construction process, encompassing tasks such as estimating and cost analysis, financial planning, guidance on tendering procedures and contracts, financial oversight of projects, valuation of ongoing work, cash flow management, and serving as expert witnesses or arbitrators in disputes, if necessary (ASAQS, 2020). For detailed insights into the multifaceted functions of the quantity surveyor, refer to the discussion in Chapter 2.

Consequently, on a construction project, the quantity surveyor is a crucial professional who possesses various skills that can be utilized during most phases of the construction project (Wao & Flood, 2016). Quantity surveyors are in high demand and the profession has faced global shortages in the past decade (Smith, 2012; Thayaparan, Siriwardena, Amaratunga, Malalgoda & Keraminiyage, 2011). Wao and Flood (2016:130) support this claim by adding that “with the trends in the construction industry, there is a high probability that there will not be enough Quantity Surveyors to cater for the oncoming and/or upcoming large international construction projects”. In agreement, the Royal Institution of Chartered Surveyors (RICS) reported in 2019 that quantity surveying is one of the occupations with the most significant staff shortages (United Kingdom construction blog, 2020). Similar to the aforementioned global trends, the Quantity Surveying profession was listed as one of the highest jobs in demand in South Africa. For example, in 2019, it was listed ninth on the list of scarce jobs in the country. In 2020, quantity surveying also appeared on the national list of high-demand occupations and correspondingly appeared on the scarce-skills list of 2023 as well (DHET, 2018; DHET, 2022). While the national number of quantity surveying graduates in South Africa has increased steadily from 433 in 2014 to 606 in 2017, it is clear from the inclusion of quantity surveying in the lists of occupations in high demand that these numbers might not be enough to meet the demands of the ever-growing sector (DHET, 2019).

1.2.1 Quantity Surveying Education

Given the shortages within the quantity surveying profession and the urgent need to meet the demands of the construction industry both nationally and internationally, it is crucial to conduct a comprehensive examination and analysis of the education provided to quantity surveyors.

Currently, in South Africa, quantity surveying education is offered at various higher education institutions. Students interested in studying Quantity Surveying can do so at a traditional university, university of technology or a comprehensive university. Students can study for a three-year BSc degree with one or two additional years to obtain a BSc honours degree at traditional university. Students can also enrol for a three-year national diploma and then advance to a BTech degree (see Appendix 1) for one year of study at a University of Technology (ASAQS, 2020; SAQSP, 2023). There are three main distinctions between a traditional university and a university of technology, namely 1) traditional universities offer degree programmes that take a minimum of three to four years to complete, 2) the entry requirements are quite specific in terms of subject choices and performance levels, and 3) the main focus is theoretical training in a specialized field. In contrast, universities of technology offer 1) diploma, certificate, and degree programmes, 2) qualifications where experiential learning is part of the programmes, and 3) programmes that are career directed and practical (Oxford University Press, 2021).

Additionally, Quantity Surveying qualifications presented at South African higher education institutions are subject to accreditation by the South African Council for the Quantity Surveying Profession (SACQSP, 2023). Quantity Surveying qualifications are on offer at various institutions, and it is essential to note that the names of the qualifications might differ from institution to institution (see Appendix 2). However, the content of the syllabus and curriculum is guided by the professional body (SACQSP) as well as the Department of Higher Education and Training (DHET) and are similar. Accredited higher education institutions include national diploma qualifications and postgraduate diplomas in Quantity Surveying. BSc and BSc honours qualifications are indicated separately on the list of accredited qualifications by the SACQSP (see Appendix 2).

Quantity Surveying qualifications are currently on offer at the following traditional universities in South Africa (SACQSP, 2023):

1. University of Cape Town (UCT),
2. University of Pretoria (UP),
3. Nelson Mandela University (NMU),
4. University of the Free State (UFS),
5. University of the Witwatersrand (WITS) and
6. University of Johannesburg (UJ).

In addition, six Universities of Technology also offer Quantity Surveying educational programmes (SACQSP, 2023), namely:

1. Cape Peninsula University of Technology (CPUT),
2. Central University of Technology (CUT),
3. Durban University of Technology (DUT),

4. Mangosuthu University of Technology (MUT),
5. Tshwane University of Technology (TUT), and
6. Walter Sisulu University of Technology (WSU).

The national accreditation from the SACQSP, and the Royal Institution of Chartered Surveyors (RICS), also accredits South African Quantity Surveying qualifications. The RICS is an international governing body serving various property industry professions. Quantity Surveying qualifications, specifically on honours level, at UCT, WITS, UFS, NMU and UP are currently on the RICS list of accredited qualifications in South Africa (See Appendix 3).

Irrespective of the variations in the qualification pathway, accreditation, or qualification names, critical (quantity surveying) skills are taught and learned during university education, which makes it crucial for institutions to carefully design their curricula to include appropriate training (Ayarkwa et al., 2011). Collaboration with industry is also vital in the development of curricula. Fundamental and shared in all Quantity Surveying curriculums is the module of building measurement, which is a core module often referred to by various names, such as Quantities, Measurement, Measurement and Design Appraisal, Quantity Surveying, or Descriptive Quantification (RICS, 2022). For this study, the term Building Measurement will be used.

The Building Measurement module is a cornerstone of quantity surveying education and a core skill required for graduates and professional quantity surveyors to master and the module focuses on measuring or quantifying certain building elements and components (McDonnell, 2010; Lee, 2013; Smallwood & Cumberlege, 2016). The quantification process takes place when dimensions are taken, read, or scaled, also called taking-off, from construction drawings with a scale ruler or indicated measurements. This information is then captured or entered on a purpose-ruled paper called dimension paper or ‘dim-sheets’ (Cunningham, 2014a). Conventional teaching of building measurement typically involves the lecturer explaining construction technology on a drawing while showing students the quantification process based on a specific set of rules (Lee, 2013).

1.2.2 Challenges in Quantity Surveying Education

Over the past few years, several international studies have highlighted difficulties in learning and teaching of the building measurement module (see section 2.8). For example, studies conducted in Nigeria, Australia, Hong Kong, the United States of America (USA), Ghana, Malaysia, and the United Kingdom (UK), among other countries, have all investigated learning and teaching challenges in the building measurement module, suggesting that learning challenges in this module are a universal phenomenon (Fortune & Skitmore, 1994; Christodoulou, 2004; Hasan & Rashid, 2005; Leung & Chen, 2008; Hodgson, Sher & Mak, 2008; McDonnell, 2010; Ostrowski, 2011; Glick, Porter & Smith, 2012; Lee, 2013; Tunji-Olayeni, Amusan, Omuh, Afolabi & Ojelabi, 2016; Goedert & Rakooei, 2016; Paul, Jatau & Zaki, 2019; Gurmu & Mahmood, 2020).

In South Africa, limited research has been done on the learning and teaching challenges in the building measurement module specifically. However, Smallwood and Cumberlege (2016) investigated some challenges and perceptions of quantity surveying and construction management students in the building measurement module specifically and found that students understood the importance of the module, not only in their studies as a core module, but also in their career and working activities as a key to cost control and estimating. Other than these authors, limited research on the building measurement module has been done in the South African context with specific reference to first-year students.

In addressing first-year students' learning and teaching challenges in the building measurement module there is a notable gap in research within the South African context. This void highlights a disparity between studies focusing on quantity surveying education and those focusing on higher education and pedagogical issues. The diagram below (Figure 1.1) illustrates this knowledge gap, showcasing existing research in quantity surveying education, specifically within the building measurement module. However, there remains a deficiency in research concerning the first-year aspect specifically. While numerous studies exist on challenges within learning and teaching, particularly those faced by first-year students entering higher education, (see section 2.3) a gap persists in understanding the challenges explicitly encountered within the building measurement module by underprepared first-year students.

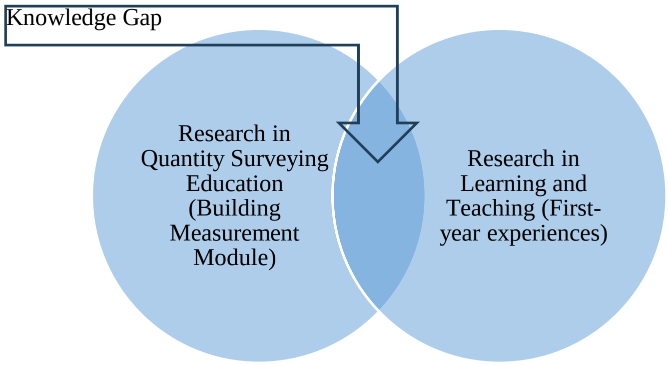


Figure 1.1: Knowledge Gap of this Doctoral Study

Within the broad scope of research on construction education, encompassing fields such as quantity surveying, architecture, engineering, and construction management, there is a notable focus on pedagogical challenges. However, there is a lack of studies specifically addressing the difficulties encountered by first-year students in the building measurement module. Conversely, while extensive research exists on first-year students' underpreparedness, there is a distinct gap in studies focusing on the specific struggles of underprepared first-year quantity surveying students, particularly concerning their primary module.

These two spheres (underpreparedness of first-year students and pedagogical challenges in the building measurement module), are combined to present the current problem at hand which is the challenges of first-year students and lecturers experience in the building measurement module.

Remarkably, no prior investigations have looked into the challenges encountered by enrolled first-year students in higher education institutions, particularly within the module of building measurement. **Thus, the potential challenges encountered with the learning and teaching of building measurement, especially at the first-year level at universities in South Africa, are at the core of the present doctoral study,** as highlighted and elaborated on in the following section.

1.3 PROBLEM FORMULATION

Since the early 1990s, there has been a growing concern regarding acquiring quantification skills through formal education. In 1994, Fortune and Skitmore suggested that the approach to teaching quantification studies in higher education should shift away from traditional lectures and practice sessions. Instead, they advocated a more dynamic learning environment, utilizing workshops that foster problem-solving abilities and promote the development of essential skills such as numeracy, communication, and organization. However, there does not seem to be a facilitation framework to guide academics for pedagogical challenges in quantity surveying educational literature, specifically on the first-year level in the building measurement module, which the present study could identify or establish. In the meantime, several studies have confirmed the challenges experienced with learning and teaching within quantity surveying and building measurement, but have yet to focus on first-year students.

Studies such as those of Ostrowski (2010) found the following pedagogical challenges in the building measurement module (note this is in the international context and not specifically for first-year students).

1. The process of teaching measurement, which refers to procedural knowledge, where students experience difficulty knowing what to do next when measuring.
2. Calculations involved in measurement, where students usually do not know how to do the numerical calculations that are required, which was found to be the most fundamental problem.
3. Insufficient knowledge of construction or building technology, where students do not know the building process they are measuring;
4. Ruling in taking-off sheet.
5. Difficulties with the lecturer either going too fast or too slow, resulting in boredom or anxiety among students.

A study by Tunji-Olayeni et al. (2016) in Nigeria found that students typically face challenges with calculation courses and fundamental learning difficulties with calculation courses and fundamental learning difficulties in the building measurement module was also discovered and included:

1. The teaching styles of lecturers that make comprehension for students difficult.
2. Lecturers rush through the work while assuming students possess certain knowledge already.
3. Limited exposure to software and locally authored textbooks on building measurement.
4. Non-interactive lectures.

5. Insufficient and non-illustrative examples for students to understand the content fully.

In a recent Australian study, Gurmu and Mahmood (2020) investigated learning challenges due to poor student performance in the building measurement module and over five years, the following learning challenges were reported in the building measurement module by these authors:

1. Difficulty in managing group assignments, where students felt that they would benefit more from individual assignments instead of group assignments.
2. Insufficient understanding of mathematics and construction technology was noted, with students expressing frustration over lecturers' assumptions regarding their proficiency in construction methods and materials, resulting in lecturers rushing through the work and leaving students frustrated.
3. Lacking sufficient time to practice seminar questions, and students feeling rushed in doing seminar activities and needed additional time to complete the work.
4. The inflexibility of the class and seminar timetables.
5. Insufficient learning resources were also found to be learning challenges in the building measurement module (Gurmu & Mahmood, 2020).

It is noticeable from these studies that challenges in the building measurement module are evident, but note that this research is done internationally and is not focused on South African first-year students. Once again, the knowledge gap is evident.

Glick and Porter (2012) highlight a notable concern, particularly regarding incoming undergraduate construction students who typically lack a robust background in the construction field. This deficiency often leads to difficulties in core content courses like construction materials and methods, plan reading, and estimating. Lee (2013) also supports this notion by adding that first-year students are poorly equipped with skills to read construction drawings, let alone measure accurately and note down the measurements in a set format. Many students find the building measurement module a challenge, especially in the first semester of their first year (McDonnell, 2010). To this effect, some authors, such as Sunindijo (2016), suggest the exploration of new learning and teaching approaches, such as flipped classrooms, learner-centred approaches and self-directed learning for first-year construction management students that would support and improve their learning experiences.

Similarly, in South Africa, the problem of students' poor grasp and comprehension of measurement has been suggested by authors such as Smallwood and Cumberlege (2016); this is, however, not specifically on the first-year level. In response, the teaching methodology of the building measurement module at a South African university underwent transformation and reconfiguration in recent years to make the presentation of this module and its content more comprehensible for students.

What compounds the learning and teaching challenges experienced in the building measurement module for first-year students in South Africa specifically is that first-year students are generally underprepared to enter higher education and have limited prior knowledge in terms of the content (Matoti, 2010; Glick et al., 2012; Thomas & Maree, 2021). Transitioning from school to higher education seems problematic for many students (Roman, Titus & Dison, 2016; Hodgson et al., 2010; Glick & Porter, 2012). Furthermore, first-year students struggle to adapt to their new environment and find the workload, teaching methods, homesickness, accommodation availability, financial support and academic support challenging (Thomas & Maree, 2021). When first-year students arrive in higher education underprepared, they exhibit a phenomenon referred to as the articulation gap, which is the difference between success at school and in higher education. This profoundly affects student performance in higher education, as the foundation for higher education studies is not firmly laid in school and this inadequate preparation for higher education is problematic. It is stated that almost 69% of all students entering higher education in South Africa are underprepared and are not able to cope with the demands of higher education (Mayet, 2016; Prince & Frith, 2020; Matoti, 2010). It is essential to bridge this articulation gap with appropriate academic support and learning development, such as teaching interventions and extra support for the most vulnerable students (Prince & Frith, 2020).

Despite students' pedagogical challenges and difficulties in the building measurement module, lecturers still favour the traditional teaching (McDonnell, 2010; Farrow & Wetzel, 2021). Various authors have questioned the efficacy of the traditional teaching approach, and it is suggested that current learning approaches and teaching orientations be evaluated and adjusted to support student learning (Hodgson et al., 2008, McDonnell, 2010, Hasan & Rashid, 2005, Sunindijo, 2016, Farrow & Wetzel, 2020). In addition to Hodgson et al.'s (2008) research, Hasan and Rashid (2005) also found the conventional teaching approach, which is similar to the traditional approach and includes tutorials, manual taking-off exercises and taking-off examples using computers to be ineffective to teach critical knowledge and skill in taking-off, which is core to the building measurement module.

Particular challenges of this conventional approach include a lack of understanding in construction technology, concepts of measurement, and a lack of skills required in taking off. This delivery approach seems to be the problem because it appears to be fragmented and uncoordinated in teaching construction technology, measurement principles, and measurement exercises. These findings of Hasan and Rashid (2005) are similar to those of Hodgson et al. (2008).

In the international quantity surveying educational context, various alternative teaching approaches to improve the learning experience of students have been proposed or implemented, such as deep learning, flipped classrooms, problem-based learning, and a learner-centred approach (Farrow & Wetzel, 2020; Sunindijo, 2016, Hodgson, et al., 2010, Lee 2013). Goedert and Rakooei (2016) also advocate that a project-based pedagogical approach be applied instead of traditional lectures in the building measurement module.

In South Africa, as noted by Zulu, Haupt and Tramontin (2018), various pedagogical methods, such as problem-based learning, studio-based learning, case-based learning, inquiry-based learning, project-based learning, action learning and discovery learning are integral components of the constructivist teaching approach. These teaching strategies or pedagogical methods underscore significant endorsement for this comprehensive teaching methodology within the field of quantity surveying. However, it is important to highlight that these findings do not specifically pertain to first-year students or the building measurement module, but to construction education in general and include all student year-groups. Various researchers, national and international support and promote constructivism in construction education. They also refer to constructivism as a widely accepted learning and teaching approach due to its efficacy of being student-centred (Mohamed, Islam, Yusof, Misnan, Othman & Ramly, 2018; Hefer, Fester, Zulu & Haupt, 2018; Hartman, Doree & Martin, 2010; Haupt & Harinarain, 2016; Zulu et al., 2018).

Consequently, to address the pedagogical challenges, the present study submits that an alternative approach to learning and teaching in the building measurement module on the first-year level, specifically, be investigated from a constructivist viewpoint to enhance the efficacy of learning and teaching. Constructivism in learning and teaching foregrounds student-centredness, peer learning, active participation and student agency, problem-solving, and critical thinking and allows students to generate and test their understanding of the work (Shah, 2019).

However, the present study notes that, notwithstanding the international studies listed earlier, there is a shortage of research in this area, particularly concerning the building measurement module related to first-year pedagogical challenges in the South African context, such as understanding the specific challenges experienced by students and lecturers and the learning and teaching approaches that might contribute to these challenges. The challenges encountered in building measurement on a global scale are likely reflected in the South African context. Moreover, these challenges are likely intensified by underprepared first-year students entering South African higher education institutions.

In Figure 1.2, the main problem of the study is illustrated, where underprepared first-year students enter higher education with limited prior knowledge of the construction industry, resulting in learning and teaching challenges. Various learning theories and approaches are investigated with a strong focus on constructivism, and Vygotsky's theory of sociocultural development is proposed as a possible solution to the challenges. The investigation is based on a pragmatic and constructivist research paradigm as presented in Chapter 4.

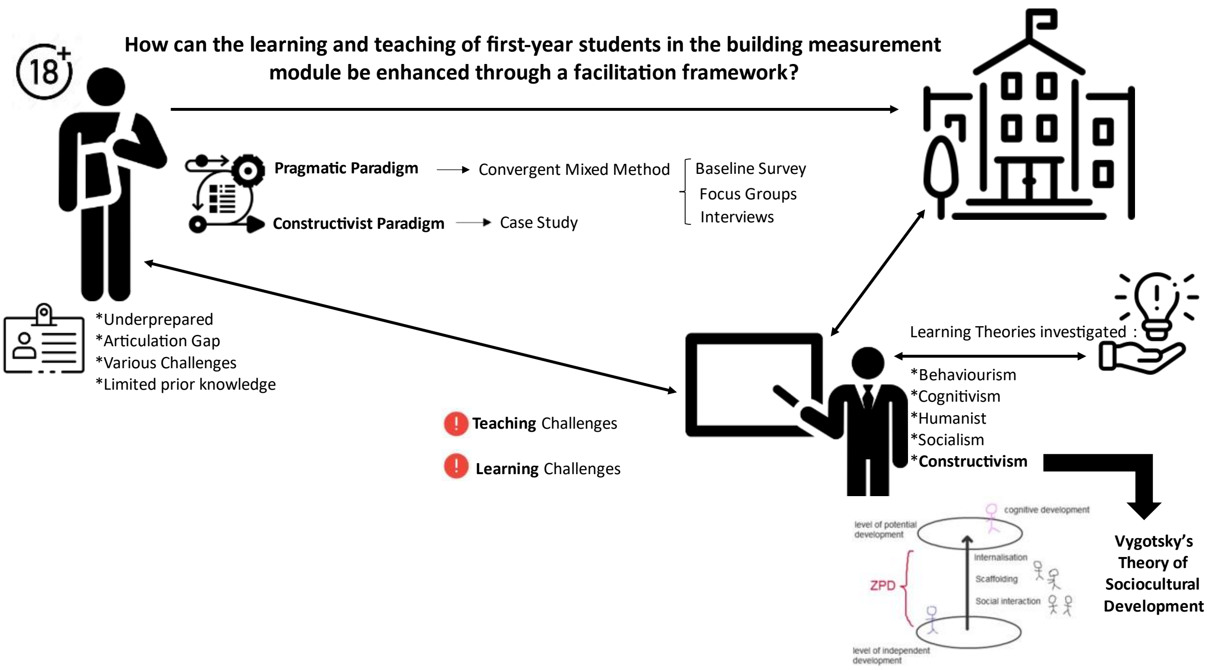


Figure 1.2: Problem Formulation of this doctoral study (Source: Author's own compilation)

The research problem that guides this study is to identify the learning and teaching challenges faced by first-year students and lecturers in the building measurement module at South African universities. Secondly, it seeks to investigate the constructivist teaching approach, with a particular focus on the applicability of Vygotsky's theory of sociocultural development as a potential solution to these challenges.

1.4 THEORETICAL PERSPECTIVE

According to the Vygotskian theory, the starting point for instruction is the student's current level of skills and knowledge. When applying the theory of Vygotsky, it is assumed that the student brings some experience to the learning situation. The combination of existing knowledge and new knowledge will lead the student to make meaning of and construct their knowledge. This combined knowledge construction and meaning-making process is known as constructivism (Harland, 2003). Constructivism in learning and teaching implies that the students learn while constructing knowledge. It holds the potential for addressing several of the challenges associated with learning and teaching in the building measurement module because students need to develop the capacity and skills to learn better and construct knowledge (Lee, 2013). The theorist Ausubel states that "the most important single factor influencing learning is what the learner already knows, ascertain this and teach him accordingly" (Harland, 2003:266). To address the pedagogical challenges faced in the learning and teaching of the building measurement module on the first-year level and the value of constructivism in construction education (as presented see section 1.3) this thesis will argue for the application of Vygotsky's sociocultural theory of cognitive development. The implementation of the scaffolding concept to assist first-year students in moving through the zone of proximal development (ZPD) and ultimately enhance their learning and teaching experience in the building measurement module. form part of the theoretical perspective and the argument for the application of the theory. As discussed and justified in Chapter 3, Vygotsky's theory primarily focuses on the complexities of cognitive activities shaped by active knowledge construction, making it a cornerstone of constructivism. According to Vygotsky, social influences, especially instructional guidance, are pivotal in cognitive development (The Psychology Notes HQ, 2018). Vygotsky's theory forms part of the broader constructivism theory, which will be explored in detail in Chapter 3 of the thesis.

1.5 RESEARCH QUESTIONS

In examining the stated research problem (see section 1.3), the following main question and sub-questions are presented:

1.5.1 Main Research Question

How can the learning and teaching of first-year students in the building measurement module be enhanced through a facilitation framework?

To address this main question, the following sub-questions are presented:

1.5.2 Subsidiary Research Questions

1.5.2.1 What is the extent of the preparedness level of first-year quantity surveying students in terms of prior knowledge or lack thereof to deal with the building measurement module content when they enter higher education for the first time?

1.5.2.2 What is the nature of the challenges associated with the learning and teaching first-year quantity surveying students in the building measurement module in South Africa?

1.5.2.3 What are the current approaches and techniques used in the learning and teaching building measurement for first-year quantity surveying students in South Africa?

1.5.2.4 What is the perceived effectiveness of the current learning and teaching approaches and building measurement for first-year quantity surveying students in South Africa?

1.5.2.5 What facilitation framework towards effective learning and teaching interventions can be applied to bridge the articulation gap of first-year students so they can fully grasp and understand the context of the building measurement module?

1.6 AIM OF THE STUDY

This research aims to develop a guiding facilitation framework to facilitate and enhance learning and teaching of the building measurement module on first-year level to mitigate and address potential pedagogical challenges associated with quantity surveying students.

1.7 RESEARCH OBJECTIVES

To achieve the above aim and address the research questions, the following objectives will be pursued:

1.7.1 To determine the preparedness level of first-year quantity surveying students in terms of prior knowledge or lack thereof to better deal with the Building Measurement Module.

1.7.2 Identify the challenges associated with learning and teaching first-year quantity surveying students in the Building Measurement Module in South Africa.

1.7.3 To examine current learning and teaching approaches and techniques used in the learning and teaching of building measurement for first-year quantity surveying students in South Africa.

1.7.4 To identify learning and teaching interventions that can be applied to bridge the knowledge gap of first-year students regarding the building measurement module.

1.7.5 To develop a guiding framework to enhance the facilitation of learning and teaching of building measurement to first-year quantity surveying students and support them in developing the required basic and professional skills.

1.8 RESEARCH METHODOLOGY

This study employs an interdisciplinary multi-method research approach to examine, blend, and unify connections across disciplines, creating a cohesive and unified facilitation framework. Its advantage lies in incorporating viewpoints from both the quantity surveying field and the realm of higher education. The primary aim of this interdisciplinary method is to address real-world, complex issues and to offer diverse viewpoints on problem-solving (Choi & Pak, 2006). In this case, the focus is on improving learning and teaching within the quantity surveying discipline, thus using learning and teaching theory to enhance and contribute to the Quantity Surveying body of knowledge.

This study’s important challenge is the lack of existing knowledge about learning and teaching and its challenges within the South African quantity surveying context, specifically related to first-year students in the building measurement module. This study’s above-mentioned identified gap influences the aim of the study, as the development of a guiding facilitation framework to facilitate enhanced learning and teaching of the building measurement module on a first-year level will only be effective if it speaks directly to the challenges and effective practices the sector experiences.

Due to the lack of contextual knowledge, this study will introduce a multimethod research approach (see full details in Chapter 4, section 4.3) to first identify the challenges students and lecturers experience in the building measurement module and secondly, use this information to inform the development and implementation of interventions that will lead to a guiding facilitation framework to enhance the learning and teaching and to overcome the challenges in the building measurement module. Furthermore, this implies that the research will not use the traditional or well-known scientific method used in most Quantity Surveying research but will draw on constructivist and pragmatic paradigms to inform the multimethod research approach.

The multimethod approach draws upon the comprehensive theory of constructivism, which is grounded in several essential principles: 1) active construction of knowledge, 2) engagement in learning as a dynamic process, 3) social construction of knowledge, 4) personalized nature of knowledge, and 5) learning taking place within the individual's cognitive processes (McLeod, 2019). The building measurement module is a cornerstone of quantity surveying education and a core skill required for graduates and a professional quantity surveyor to master (McDonnell, 2010; Lee, 2013). Fortune and Skitmore (1994) urge the development of problem-solving abilities, utilizing numeracy, communication and organisational skills for quantity surveying graduates. As already stipulated (see section 1.3), constructivism is foregrounded as foundational to the argument that learning and teaching in building measurement, particularly for first-year students, should encompass these principles to bridge the articulation gap of first-year students and create exceptional learning and teaching experiences despite their underpreparedness.

Figure 1.3 presents the multi-method research approach adopted for this study.

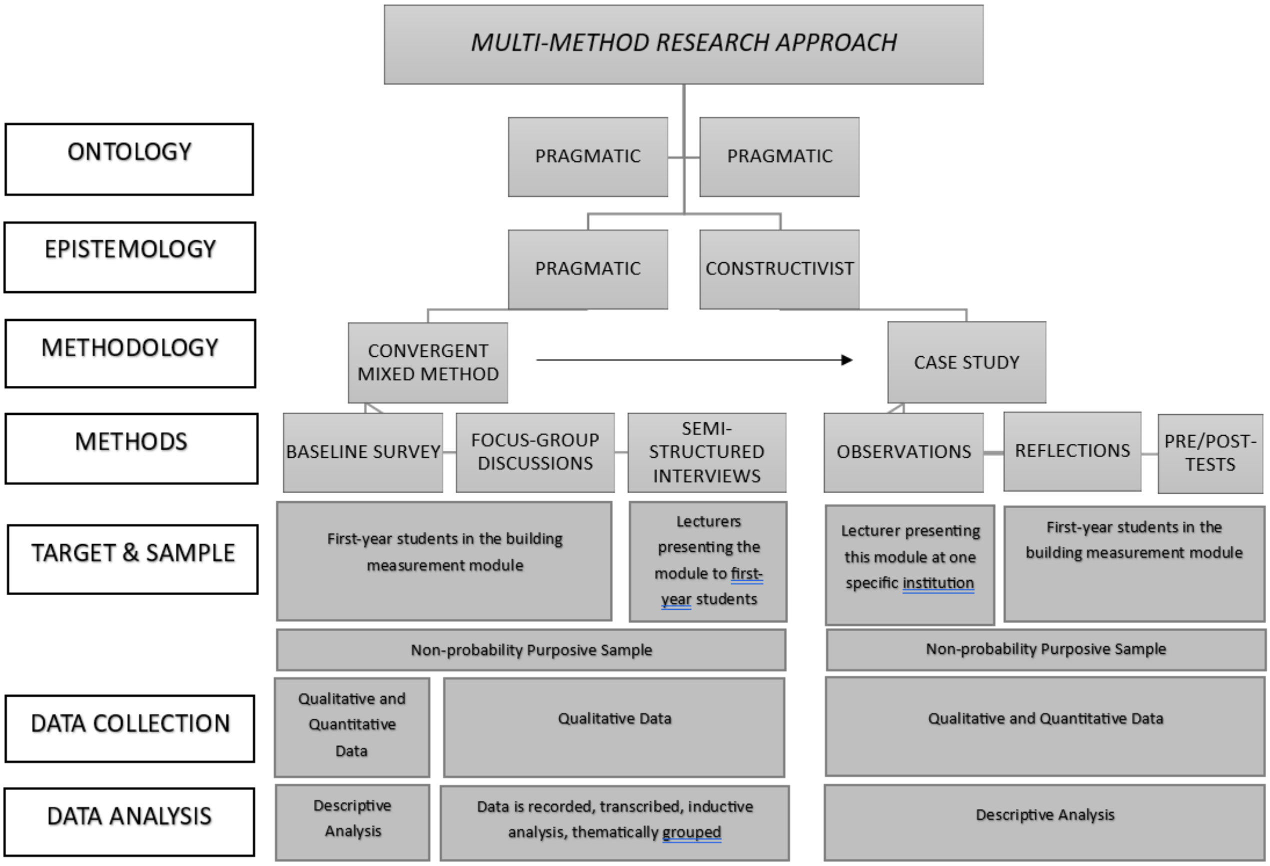


Figure 1.3: Research Methodology Framework of this Doctoral Study (Source: Author's own compilation)

1.8.1 Methodology One

The first methodology will draw from the pragmatic paradigm and implemented a convergent mixed-method design. Chapter 4 of the study will present full details of this methodology. The primary purpose of the first methodology is to determine the challenges of first-year students and lecturers in the building measurement module at South African universities. Data on the nature of learning and teaching challenges, the preparedness level of first-year students entering higher education for the first time, and the current learning and teaching approaches and their perceived effectiveness were gathered. This first methodology approach involved conducting an online baseline survey and focus-group discussions with enrolled first-year students in the building measurement module. Additionally, semi-structured interviews were conducted with lecturers who teach the building measurement module on first-year level.

The target population for the convergent mixed method included first-year students registered for the building measurement module at various universities in South Africa offering accredited quantity surveying programmes. Students were asked to participate in the study in terms of the online baseline survey and the focus-group discussions. Furthermore, lecturers presenting the building measurement module on the first-year level were also invited to participate in the study through semi-structured interviews. Five traditional universities are presenting accredited Quantity Surveying programmes and that offer the building measurement module at first-year level; one university offers the building measurement module from the second year.

Regarding students, the first-year cohort of various universities were invited to participate in an online baseline survey, which mainly aimed to identify the students' preparedness levels upon university entrance, and face-to-face focus-group discussions, focusing on the students' learning and teaching experiences in the building measurement module. Three focus groups per university were planned, with a total of seventy (70) participants. (Full discussion in Chapter 4, section 4.5.3.) Participation in the baseline survey and the focus-group discussions is voluntary. It was estimated that 150 students would engage with the online survey.

A non-probability purposive sampling technique was applied for the first-year building measurement lecturers. The sample consisted of four lecturers (one from each institution offering accredited quantity surveying progammes) to participate in the study. Lecturers engaged in semi-structured interviews focusing on their teaching approaches, the perceived effectiveness of these approaches, and the challenges they experience in learning and teaching the building measurement module on first-year level.

Semi-structured interviews and focus-group discussions were recorded and transcribed. Data obtained were analysed thematically. The data obtained from the baseline surveys, focus-group discussions and the semi-structured interviews were triangulated and then used to inform the second methodology, as explained in the next section.

1.8.2 Methodology Two

Opposed to the first methodology, the second methodology draws from the constructivist paradigm and follows a case-study design. The case-study design involved qualitative and quantitative data collection with an in-depth investigation into a single student cohort at one identified university offering an accredited quantity surveying programme. The case study took the information gathered through the first-round methodology to inform the development and implementation of teaching interventions, using the constructivist approach, to ultimately produce a guiding facilitation framework of good learning and teaching practices for the building measurement module for first-year students. Full details of this methodology are presented in Chapter 4 of the study.

For the case study, the first-year student cohort in a university's building measurement module was targeted for participation. A non-probability purposive sampling technique was applied.

Data obtained from the first methodology were used to inform the case study and to determine the appropriate teaching interventions for the case study. Teaching interventions developed from these data were limited to a maximum of five (e.g. subjected to pre- and post-tests, lecturer observations, and students' self-reflections on their learning and teaching experiences). Thus, data obtained from the case study were qualitative and quantitative by nature, but predominantly qualitative.

Due to limited research in the South African quantity surveying educational context, even more specifically on the building measurement module on the first-year level, this research aimed to add to the body of knowledge of quantity surveying education in South Africa in terms of enhancing the performance and learning experiences in the building measurement module. This research also aimed to add to the learning and teaching body of knowledge regarding demonstrating the value of constructivism as a teaching approach in quantity surveying education. The value of the research would be reflected in the contribution of a guiding framework to facilitate learning and teaching for the building measurement module on the first-year level to narrow the articulation gap and address the level of preparedness of the students entering higher education. Thus, this research's practical implication aimed to lead to enhancing the quality of learning and teaching of the building measurement module in quantity surveying programmes in South African universities. This research might also lead to an inter-institutional discussion on best practices for learning and teaching in quantity surveying education and the support of first-year students entering higher education.

Theoretically, the study would contribute significantly to the quantity surveying body of knowledge where a knowledge gap has been identified especially relating to the learning and teaching of first-year students. Through a multi-method research approach, the knowledge contribution would mainly fall into the higher education context, but with specific reference to first-year students in quantity surveying programmes.

1.9 ETHICAL CONSIDERATIONS

As outlined by Leedy and Ormrod (2015), ethical guidelines are paramount in mixed-method research. These guidelines include securing voluntary and informed consent, safeguarding participants from harm, and respecting their right to privacy. Similarly, Kumar (2014) emphasizes the importance of navigating potential ethical challenges in various research processes. These include collecting information, obtaining consent, offering incentives, addressing sensitive topics, mitigating potential harm, and ensuring confidentiality. Given these considerations, the researcher obtained ethical clearance (see Ethical clearance approvals in Appendices 6–10) from relevant institutions (see details section 4.9) to ensure adherence to ethical standards throughout the research process. The following ethical guiding principles applied to this study:

1.9.1 Informed Consent/Assent

In ethical research, informed consent plays a crucial role. It involves presenting individuals with comprehensive information about the nature, risks, and potential benefits of the proposed study, empowering them to make informed decisions regarding their participation. Before the focus-group discussion, semi-structured interviews and case-study interventions commenced, the researcher explained the nature, risks and benefits of the research study to the participants. Ultimately, informed consent is critical to protecting individuals' rights, safety, and well-being and upholding ethical research principles. As participants in this study, students gave their verbal and electronic consent to participate in the online baseline survey as well as the focus-group discussions and, ultimately, for the case study, the participants had to provide written informed consent. Only students of legal age and capacity participated in this research. Lecturers who participated in the study also gave their verbal consent before participation in the semi-structured interviews. Participants in this research were not forced to participate; involvement was entirely voluntary. Moreover, participants retained the right to withdraw from the study at any point without facing any consequences.

1.9.2 Confidentiality and Anonymity

Confidentiality and anonymity are essential considerations when personal information is collected. Confidentiality refers to the protection of personal information, while anonymity refers to the protection of personal identity.

All data are presented in an unidentifiable form, such as using pseudonyms or by referring to interviewees 1, 2, etc., and focus groups 1, 2, etc., or respondents or participants 1, 2, etc. Only the researcher had access to data stored on a password-protected laptop and documents stored in a locked cabinet.

Confidentiality measures involved in this study are that personal information from the online baseline survey, semi-structured interviews, focus-group discussions and the case study would only be accessible by the researcher, the research supervisor of this study, and the transcriber of the data.

On the other hand, anonymity measures involve removing any identifying information from data so that individuals cannot be identified. For the semi-structured interviews, the identity of the interviewees was different from the baseline survey where the participants' identity was not possible to determine. Anonymity could not be guaranteed during the focus-group discussions, as students might know one another. Still, in terms of the data presentation, it would not be possible to identify any of the participants in the focus groups. In the case study, the identity of the participants was also not presented in any results. Both confidentiality and anonymity are essential to ensuring that individuals feel comfortable sharing personal information and that their privacy is respected and protected.

1.9.3 Vulnerable Participants

Vulnerable participants are individuals who may be at increased risk of harm or exploitation when participating in research studies. There was a risk of vulnerability because of the power relation on the part of the researcher, as the researcher was the lecturer of the module under investigation, especially in this case-study approach. Students might feel compelled to participate in the case study; extra measures to ensure students feel protected and not obligated had to be taken by the researcher, such as regular reminders about voluntary participation, and that students could withdraw at any time without any consequences. The benefit of this research outweighs the risk and the researcher undertook to conduct ethical and responsible research that contributes to the body of knowledge. To mitigate the risk, students were not forced to participate in the research study in any way. Participation remained voluntary, and the participants could withdraw at any time without any consequences.

1.9.4 Power Relationship

A power relationship existed between the researcher and some participants with specific reference to the case study. The researcher was also the lecturer of this cohort. The power relationship between the lecturer and students, or the researcher and the participants, is an important dynamic to consider. This dynamic can be positive or negative; on the one hand, this power dynamic can facilitate and enhance the learning process by providing once-in-a-lifetime research opportunities which can be utilised to contribute to the body of knowledge. On the other hand, it could be negative whereby students experience manipulation and dysfunctional behaviour by the lecturer. Lecturers should tread very carefully in this domain and be mindful of the impact on their students. A positionality statement is included in the study, see Chapter 4, section 4.10.

1.9.5 Conflict of Interest

A conflict of interest occurs when an individual or organization faces conflicting loyalties or interests that might impede their capacity to act impartially and prioritize the well-being of others. Within research or professional settings, such conflict may arise from financial, personal, or professional interests, potentially having an impact on their actions, decisions, or recommendations. Conflict of interest can undermine the integrity and credibility of research. To prevent conflict of interest, individuals and organizations must be transparent about their interests and disclose any potential conflict to others. They must also manage or mitigate conflicts, such as avoiding situations where their interests may compromise their integrity, establishing clear guidelines and ethical standards, and seeking independent review or oversight.

The researcher had an intentional interest in executing this research as this was to obtain a doctoral qualification after the completion of this research. However, the researcher prioritised the enhancement of learning and teaching of first-year students in the building measurement module.

1.9.6 Beneficiation, Reciprocity and Remuneration

No participant would benefit financially from this research.

1.9.7 Deception

Deception in research occurs when researchers intentionally provide false or misleading information to participants, withhold information or manipulate it. It is generally considered ethically problematic, because it undermines the researcher and the participants' trust, potentially harming the participants. Deception can take many forms, such as using confederates or actors in research, providing false feedback or information, or misleading participants about the study's true purpose. The real purpose of the research was known by the students, as the research process and involvement were clearly explained to the students as participants before the process commenced.

1.10 PLANNED OUTLINE OF STUDY

The study is divided into seven chapters:

Chapter 1: INTRODUCTION AND PROBLEM SETTING. Chapter 1 introduces the research context, formulates and states the problem, identifies the research aims and objectives, and highlights the study's contribution and importance. This chapter presented the learning and teaching challenges of building measurement at the first-year level. In this chapter, the problem statement and research questions are presented together with an overview of the objectives and scope of the research. In the last section of this chapter, an overview of the selected research methodology and the ethical considerations applicable to this study summarized.

Chapter 2: LEARNING AND TEACHING AND THE QUANTITY SURVEYING PROFESSION: LITERATURE REVIEW. In Chapter 2, the quantity surveying profession is explored. A historical perspective is presented about the quantity surveying profession as well as the evolvement of the profession as it is known today. Key responsibilities, roles, skills, and competencies of the quantity surveyor are presented, and a strong focus on the measurement skills of the quantity surveyor is given. It also discusses the learning and teaching landscape in the international as well as the South African landscape and pedagogical challenges in the building measurement module are investigated and reported on.

Chapter 3: THEORETICAL FRAMEWORK: CONSTRUCTIVISM AND VYGOTSKY'S THEORY OF SOCIOCULTURAL DEVELOPMENT. Chapter 3 presents the conceptual framework developed for this research. In this chapter, learning theories will be presented, and constructivism will be investigated in depth, whereafter Vygotsky's theory of sociocultural development will be discussed in detail with specific reference to elements such as scaffolding and the zone of proximal development.

Chapter 4: RESEARCH METHODOLOGY: LITERATURE AND APPLICATION. Chapter 4 explains and justifies the research methodology employed in this study and the research approach and design. Through the application of a multi-method research approach, the research questions will be answered, and study objectives will be achieved. This study will draw on the pragmatic and constructivist paradigms with a convergent mixed-method approach and a case-study design.

Chapter 5: RESEARCH FINDINGS, PRESENTATION AND ANALYSIS. Chapter 5 presents the findings from the data collection of the first methodology, the convergent mixed method. Data collection from the baseline survey, focus-group discussions with first-year students, and semi-structured interviews with first-year lecturers of the building measurement module are presented, analysed and discussed.

Chapter 6: CASE-STUDY FINDINGS. In Chapter 6, the findings of the case study and the second methodology are presented. Data obtained from pre-and post-tests, participant observation, and reflections are presented. The data from the first methodology informed the case-study design.

Chapter 7: FRAMEWORK, CONCLUSIONS AND RECOMMENDATIONS. In Chapter 7, the guiding facilitation framework is presented, the study is concluded, and recommendations are made. Contributions to the body of knowledge will be presented, and areas for further research will be discussed.

1.11 CHAPTER SUMMARY

In this chapter, I have outlined the study's broad context, including formulating the research problem and presenting research objectives. Additionally, I have provided insight into the chosen research methodology and the ethical considerations guiding the study. Moving forward, chapter two presents the literature review. The significance of this study is underscored by the lack of contextual knowledge regarding the learning and teaching challenges faced by first-year quantity surveying students, particularly in the building measurement module. The primary aim is to identify and understand the challenges experienced by students and lecturers, with the ultimate goal of proposing a facilitation framework to enhance learning and teaching within the building measurement module. It is crucial to recognize that quantification is a fundamental skill for professional quantity surveyors, making it paramount in the education of aspiring professionals at higher education institutions.

CHAPTER 2

LEARNING AND TEACHING AND THE QUANTITY SURVEYING PROFESSION

LITERATURE REVIEW

"We need to stop just pulling people out of the river. We need to go upstream and find out why they're falling in."

-Desmond Tutu-

2.1 INTRODUCTION

This chapter presents an overview of learning and teaching in higher education in the broader international context and South African higher education within the quantity surveying learning and teaching landscape (section 2.2). Understanding the significance and purpose of higher education and the learning and teaching approaches used in higher education is essential. A paradigm shift in learning and teaching might be needed due to the rapidly changing world, and the construction industry is no exception. To adjust to these changes, future construction professionals must be educated and trained to adapt to the workforce to execute vital services. Quantity surveying graduates and professionals fulfil a critical role in the construction industry, which ultimately impacts a country's economy. Therefore, it must be ensured that appropriate, good-quality teaching is taking place at higher education institutions from the first-year level, as discussed in section 2.3. This chapter introduces the quantity surveying profession (section 2.4), which leads to a discussion on the core services, competencies, and skills of the professional quantity surveyor (section 2.5). It is essential to understand the core skills required of the quantity surveyor, of which quantification skill, also known as measurement or taking-off, is one of the core skills requirements (section 2.6).

Higher education institutions are responsible for training, educating, and developing young, dynamic quantity surveying professionals through independent and autonomous learning. However, the challenges within this domain need to be investigated, and possible solutions must be proposed. Among the various challenges within the higher education setting, a specific focus must be on the learning and teaching, also known as pedagogical challenges, experienced by students and lecturers. There are specific concerns about first-year students' readiness and preparedness to enter higher education, and several authors have written about it. The specific content of these writings will be expanded on later in this chapter (section 2.3.1) (Roman et al., 2016; Reddy, Nair & Reddy, 2014; Mouton, Louw & Strydom, 2013; Du Plessis & Gerber, 2012; Mudhovozi, 2012; Matoti, 2010; Haupt, 2009; Engelbrecht, Mostert, Pienaar & Kahl, 2020).

Underpreparedness of students is a universal phenomenon and has a significant impact on the performance and retention of students at higher education institutions (Wollscheid, Lodding & Aamodt, 2021; Thomas & Maree, 2021; Paul et al., 2019; Prince & Frith, 2020; Malatji & Singh, 2018; McGhie, 2017; Mayet, 2016; Mavunga, 2014; Jansen & Van der Meer, 2012).

Students in construction education courses, specifically quantity surveying, are no exception. With very little experience and knowledge about the built environment or the construction industry, first-year students are thrown at the deep end when they enter higher education institutions for the first time to study towards a quantity surveying qualification. Pather and Dorasamy (2018) strongly advocate the necessary response to support first-year students adequately. This first-year support might necessitate changing first-year students' learning and teaching approaches to support them better while transitioning from secondary school into higher education and construction education courses. Various authors have noted numerous challenges in learning and teaching in construction education, specifically in the building measurement module. These challenges will be presented later in this chapter (section 2.8).

The general underpreparedness of first-year students and the pedagogical challenges experienced by students and lecturers in the building measurement module stress the importance of this chapter, where the challenges of underprepared first-year students, specifically in the building measurement module, are investigated and presented. Lastly, alternative learning and teaching approaches are explored to enhance the learning and teaching experiences in the building measurement module on first-year level and to support the students in transitioning from secondary school to higher education better.

2.2 LEARNING AND TEACHING IN HIGHER EDUCATION

Learning involves a diverse array of processes that extend beyond mere memorization. It encompasses mastering abstract principles, comprehending proofs, recalling factual information, acquiring methods and techniques, analysing and debating ideas, and adapting behaviour to suit different contexts. Vorster (2011) cautions against assuming that learning automatically results from teaching efforts. Instead, learning necessitates opportunities for practice and exploration, room for contemplation and reflection, and engagement with peers. For effective learning, students must be interested, prepared, and motivated to participate in the educational journey (Fink, 2013; Fry, Ketteridge & Marshall, 2009; Abdelhamid, 2003). Ambrose, Bridges, DiPietro, Lovett and Norman (2010) define learning as a transformative process that demands active student involvement and accountability. Moreover, successful learning relies on the guidance of dynamic and innovative educators who cultivate critical thinking and foster a spirit of discovery and inquiry among their students (Russel, Hanna, Bank & Shapira, 2007).

2.2.1 Higher Education and Teaching

Good lecturers should be empathetic, have enthusiasm, be creative and be able to instil discipline (Maphalala, 2016). Further, the lecturer needs to exhibit enthusiasm and passion, assist students in developing critical thinking skills, and give constructive feedback on assessments. Effective lecturers can also enhance students' learning with skills and characteristics to contribute to and improve students' knowledge (Heffernan, Morrison, Sweeny & Jarratt, 2009; McMillan & Gordon, 2017).

Davis and Arend (2013) provide a valuable framework for thinking about and organizing teaching that includes setting clear goals expressed as learning outcomes, ensuring a good match between learning outcomes and the chosen ways of learning, conducting well-organised teaching based on the concepts and practices inherent in each way of learning, having engaging and stimulating materials and activities where appropriate, and implementing assessment methods that measure if learning outcomes are being achieved.

This teaching organisation indicates that for learning to take place effectively, the lecturer must ensure that the course design, the selection of learning and teaching opportunities, and the assessment assist the learner in learning. The learning and teaching can be of high quality through constructive alignment of all aspects of the module. Good subject design is about planning and aligning what to teach, how to teach, and how to assess, allowing students to engage in a coherent learning experience. Well-designed subjects make it easier for lecturers and students to maintain their focus on the learning intended while studying the subject (Hunt & Chalmers, 2021).

Unfortunately, society's expectations regarding the quality of education for students are often unmet, and students sometimes experience disjointed, unstructured and outdated education (Diamond, 2008). In many instances, the results or outcomes intended are not obtained through the curricula. The construction industry courses are not shielded from this, and various authors have mentioned the mismatch between industry and higher education (Kibwami, Wesonga, Manga & Mukasa, 2021; Haupt, 2009; Leung & Chen, 2008). Ultimately, this mismatch can influence the overall quality of higher education.

2.2.2 Higher Education and Industry

Higher education institutions play an essential role in developing students who can join the work environment and function efficiently. To do so, the focus should increasingly be on developing students towards critical thinking, understanding and innovation to be responsive to industries and how they might change (Suhaida, Nurul, Razak & Shazwan, 2019; Haupt & Harinarain, 2015; Nompunga, 2013; Ayarkwa et al., 2011; Verster & Hauptfleisch, 2009). Lange (2011) proposes that an essential function of a university is to educate the youth to engage with any future crisis in a critical, constructive and intelligent manner. Higher education must stretch students' critical thinking, creativity and synthesis, and much-needed help and support must be provided to promote the students' ability to think independently (Fry et al., 2009). The possibilities opened by a good education are endless, and the power of education is simply remarkable (Lange, 2011).

Chan, Chan, Scott and Chan (2002) highlight that academics, associations and society are concerned with professional education and training, which take place through university education. There is a correlation between Chan et al. (2002) and Lange's (2011) view that universities provide students with professional values, integrity, and competence knowledge. Thus, the learning experiences at higher education institutions are vital for the professional development of students and, ultimately, a profession such as quantity surveying. During university education, critical skills are learned. Hence, it is crucial for providers of quantity surveying education to design their curricula meticulously to incorporate the necessary training and growth opportunities. The responsiveness of education providers to the needs of the industry is essential, and there should be a strong focus on the content of the curriculum, the rules of progression within it, and its outcomes (Lange, 2011). Collaboration between higher education and industries is essential to establish a point of equilibrium where competent graduates are delivered to the world of work. Professionals in educational roles, including educators, mentors and advisors, play a vital role in preparing the next generation of professionals (Russel et al., 2007). It is essential to incorporate practices like critical thinking, embracing globalization and fostering social awareness consistently into students' learning journeys at higher education institutions. Furthermore, higher education institutions must be capable of adjusting to the evolving demands placed on students, which extend beyond technical proficiency to encompass skills such as creativity, communication, innovation, teamwork and entrepreneurship (Ayarkwa et al., 2011). Developing these skills and academic skills should be presented in a well-structured curriculum, and appropriate teaching approaches should be followed during the learning process.

2.2.3 Higher Education and a Paradigm Shift

A paradigm shift might be needed to ensure quality education in the ever-changing environment – away from the current paradigm of lecturers occupying about a fourth of the classroom space standing in front of an entire class while students are sitting, taking notes or making short summaries during the lecture.

Generally, a prevailing argument suggests a reluctance to embrace innovative teaching methodologies attributed to factors such as entrenched habits, comfort zones, limited awareness of alternative approaches, fear of ridicule, or adherence to social norms among academics (Davis & Arend, 2013). The awareness of the issues with these traditional teaching methods is growing amongst academics and students, as illustrated by the increased literature on alternative learning and teaching practices (Davis & Arend, 2013; Fink, 2013; Farrow & Wetzel, 2020). Farrow and Wetzel (2021) refer to the traditional teaching method as the "stand-and-deliver" lecture, which is still widely prevalent in higher education, although it has generally been accepted as less effective than other pedagogical practices that foster cognition and retention. Another downfall of this traditional lecture paradigm is the exclusive exposure to lecturing. It leaves students shortchanged in the skills and abilities needed the most in the twenty-first-century workplace. Research has shown that students prefer active, participatory and experiential learning (Ekundayo, Shelbourn & Babatunde, 2021; Farrow & Wetzel, 2021; Mojtahedi, Kamardeen, Rahmat & Ryan, 2020; Lee, 2013).

Concerning a paradigm shift, many lecturers might be ready to explore alternatives, but might be overwhelmed with various options. For example, university lecturers might be confronted with alternative teaching approaches: active learning, problem-based learning, learner-centred teaching, inquiry-based teaching, andragogy learning styles, cooperative learning, and collaborative learning. These teaching options might be confusing and are often difficult to navigate (Davis & Arend, 2013). An additional pressure on university lecturers is the awareness of changes and challenges within the current industry that urge them to align the skills, competencies and knowledge they produce in graduates with the demands of the construction industry. Moreover, the swift advancement of information technology and its pervasive integration into various facets of society have transformed societal norms, necessitating the emergence of a fresh cohort of professionals (Christodoulou, 2004). This concept could additionally contribute to the heightened pressure lecturers experience, having an impact on their instructional methodologies.

To support this paradigm shift, Davis and Arend (2013:3) suggest focusing on learning and less on teaching. These authors ask, “What do teachers/lecturers do to facilitate learning?” They recommend that lecturers should learn about learning.

This section provided an overview of learning and teaching in higher education and how some authors have argued for a paradigm shift from focusing on teaching to questioning how learning takes place. This paradigm shift is important to align students’ learning with the rapidly changing demands of the workplace.

The focus now turns to first-year students as an essential starting point for changing paradigms in learning and teaching in higher education.

2.3 FIRST-YEAR STUDENTS IN HIGHER EDUCATION

First-year students in higher education are typically enthusiastic and eager to explore new academic and social opportunities while navigating the challenges of increased independence and responsibility.

2.3.1 First-Year Students and (Under)Preparedness

In addition to the changes and challenges mentioned in the preceding section, the basic schooling system in South Africa does not prepare students enough for higher education

(Mudhovozi, 2012; Mouton et al., 2013; Thomas & Maree, 2021). Undergraduate academic success is affected by students who struggle with adjustment to the higher education environment due to attending poorly resourced schools. In addition, Haupt (2009) found the standard of secondary education to be poor, as well as low-quality entry-level students, prevalent in South Africa, with specific reference to the construction-industry-related courses.

Academic preparedness is a multidimensional, overarching concept that includes reading, writing, note-taking and the ability to take an examination (Matoti, 2010; Wollscheid et al., 2021). These skills are paramount to academic development and success. The specific skills first-year students lack when entering higher education are reading, writing and mathematical skills. English proficiency is also sometimes lacking, because it might be a student's second or third language. Numeracy skills are not proficient, and this lack can be attributed to the shortcomings in the learning and teaching of mathematics and the English language at school level (Lemmens, Du Plessis & Maree, 2011; Prince & Frith, 2020). Mavunga (2014) supports that numeracy and literacy skills contribute to the problem of underpreparedness. Reddy et al. (2014) also found that first-year students have low competency levels in maths, resulting in challenges in analytical thinking and abstract work in higher education. Academic preparedness is not only a South African phenomenon. Studies in Norway, the United Kingdom, and Australia also suggest that students lack writing and reading skills when entering higher education (Wollscheid et al., 2021; Lowe & Cook, 2003; Nallaya, Hobson & Ulpen, 2022).

When exploring the causes of underpreparedness among first-year students, various factors emerge. These include insufficient subject knowledge among science and math teachers and deficiencies in communication skills among teachers and learners. Additionally, the absence of adequate instructional materials and textbooks and the pressure to cover examination-driven syllabi worsen the issue. The overcrowding of classrooms and the absence of basic facilities like toilets and libraries further compound the challenges faced by underprepared first-year students entering higher education (Matoti, 2010; Mavunga, 2014).

Educational inequalities and poor educational performance characterise the South African basic education system, which can also lead to underprepared first-year students entering higher education. The availability of textbooks, poor infrastructure and equipment, and the shortage of teachers contribute to the dilemma in the basic education system (Roman et al., 2016).

2.3.2 The Articulation Gap

When students arrive at higher education institutions underprepared, they exhibit a phenomenon referred to as the articulation gap, which is the difference between success at school, at university, or in higher education (Mayet, 2016). One of the features of the articulation gap is students' numeracy practices and the expectations of higher education. Malatji and Singh (2018) found that the articulation gap among first-year students makes it hard for them to cope with the demands of higher education.

The articulation gap is part of the underpreparedness of first-year students, and Matoti (2010) mentioned that there are three areas of underpreparedness among students entering higher education, namely i) academic, ii) cultural, and iii) emotional underpreparedness. The basic education system is to blame for this, according to Mavunga (2014), who claims that the poor quality of basic education has a knock-on effect on higher education institutions. When students transition from school into higher education, it is essential to bridge the articulation gap with appropriate academic support and learning development provided by higher education (Mayet, 2016; Pather & Dorasamy, 2018).

2.3.3 Transitioning Challenges

Jansen and Van der Meer (2012) define transitioning as adapting to the subsequent stage. They outline four significant reasons why students may struggle during this transitional period. These include unsatisfactory experiences, difficulty coping with academic demands, incorrect choice of course, and a variety of personal factors such as financial issues, illness and family circumstances, all of which can contribute to students dropping out in their first year. Strydom, Kuh and Loots (2017) concur with this assertion and further emphasize that first-year students encounter significant academic and non-academic transitional hurdles.

In the United States, Mills, Novak and Danford (2012) found that 60% of incoming first-year students lacked essential learning and studying strategies, particularly in attitude and time management, upon entering higher education. In Australia, Brooker, Brooker and Lawrence (2017) have investigated challenges experienced by first-year students. They found that students in their first year of study face multiple difficulties, including time management, workload, family and health concerns, and financial worries. While entering higher education means a whole new environment, transitioning from school to higher education also means more independence, which might be challenging for some students (Wollscheid et al., 2021).

There is difficulty in transitioning students from high school to university. Some students find the transition very stressful and demanding and face challenges such as academic performance, adapting to campus life, independence, financial issues, and time management (Engelbrecht et al., 2020). McGhie (2017) believes that students find the following challenges, in addition to those previously mentioned when entering university: heavy workload, lack of motivation, and insufficient foundational knowledge. Mudhovozi's (2012) study identified various social and academic adjustment hurdles encountered by first-year students, including issues related to cultural differences, the anxiety associated with leaving family behind, difficulty in disconnecting from high-school friends, adapting to new dress codes and cuisine, managing noise levels, struggling with low self-esteem, facing shortages of reference materials, lacking a consistent study environment, grappling with fear of failure, and adjusting to diverse teaching methodologies.

This evidence shows that first-year students experience various challenges upon entering higher education. The articulation gap and transitional challenges prove that students are underprepared to enter higher education.

2.3.4 Consequences and Remedies of Underpreparedness

Students grappling with underpreparedness often encounter various consequences, including deficient study skills, resorting to surface-level learning strategies, diminished intrinsic motivation, and a lack of self-efficacy (Malatji & Singh, 2018). Additionally, they rely heavily on lecturer support and struggle to allocate study time effectively, cope with academic workloads, and navigate sizable class settings, leading to increased anxiety and eventual dissatisfaction with their academic course (Matoti, 2010).

Mudhovozi (2012) recommends that social networks and efficacious beliefs are two strategies for first-year students to cope with their stress and challenges. Wilson (2009) advocates the transition process not to be only a once-off orientation event, but to ensure this process is ongoing to facilitate the transition of first-year students into higher education. Students cannot succeed independently and need all role-players' assistance and support in learning (McGhie, 2017). Strydom et al. (2017) highlight that explicit interventions aimed at developing first-year students yield significant outcomes on crucial success indicators, including persistence, academic performance, and fostering a sense of lifelong learning.

As mentioned earlier, one of the consequences of underprepared first-year students entering higher education is dissatisfaction with the academic course, ultimately leading to students not graduating within the given study timeframe or dropping out of the course. The quantity surveying profession cannot afford to lose graduates, as this is one of the professions in high demand internationally and in South Africa (section 1.2). Thus, it must be a priority for the industry, academics and higher education institutions to support the incoming students who are generally underprepared due to the failing school system, as mentioned earlier in the chapter (section 2.3.1). The quantity surveying profession is demanding, and quantity surveyors must have appropriate competencies and skills to perform cost management, cost control, and cost advice services.

The following sections will focus on exploring the quantity surveying profession in general before turning back to quantity surveying education in subsequent sections.

2.4 THE QUANTITY SURVEYING PROFESSION

Quantity surveying is a profession that involves managing all costs related to building and civil engineering projects, from initial estimates to final accounts, ensuring value for money while adhering to quality and regulatory standards.

2.4.1 Historical Overview of Quantity Surveying Profession

During the 17th century, Quantity Surveying began to emerge as a profession, particularly evident during the restoration of London following the Great Fire. However, it was not until 1836 that the first fully measured and tendered contract using detailed Bills of Quantities (BoQ) (Shafiei & Said, 2008; Noor, Tobi & Salim, 2020). The earliest known quantity surveying firm dates back to 1785, with the inception of the first measurement method recorded in Scotland in 1802. Consequently, the quantity surveying profession boasts a distinguished history rooted in providing financial expertise to the construction industry.

In the late 1700s, various terms such as ‘measurer’, ‘custom surveyor’, or simply ‘surveyor’ were used to describe individuals in this field. However, it was not until 1859 that the term ‘quantity surveyor’ was formally coined, marking its evolution into a recognized consulting profession. The professional title of Quantity Surveyor, originating from the United Kingdom, is recognized across all Commonwealth countries (ASAQS, 2020; Seeley, 1999). In North and South America, China, and certain regions of Europe, the term ‘Cost Engineering’ is employed.

In contrast, in various European countries and other global locales, the term ‘Construction Economist’ is prevalent. Despite differing terminology, Cost Engineering and Quantity Surveying encompass similar and extensively overlapping functions. While Quantity Surveying primarily pertains to the construction sector, Cost Engineering is more closely associated with engineering projects and processes. Nevertheless, practitioners in both disciplines frequently operate in both domains (Smith, 2012).

The emergence of the Quantity Surveying profession in South Africa during the 1870s was significantly shaped by the emerging mining industry. This period saw a notable influx of British architects drawn to centres like Johannesburg, Pretoria and various coastal towns to drive the development of infrastructure required for mining operations. These architects brought expertise in quantity systems, tendering processes, and contractual frameworks. However, as projects progressed, it became evident that their approaches lacked comprehensive measurement and quantification methodologies. Recognizing these shortcomings, the first qualified quantity surveyors arrived in South Africa at the beginning of 1896 (Maritz & Sigle, 2012). The Architects’ and Quantity Surveyors’ Private Act (No 18 of 1927) was implemented. In 1971, it was amended to the Quantity Surveyors’ Act (No 36 of 1970), and again, the Act was amended in 2000 and changed to the Quantity Surveying Profession Act No 49 of 2000 (RSA, 2009; Maritz & Sigle, 2012). This legislation serves the profession today and strives to uphold professionalism and ethical conduct.

2.4.2 Current Quantity Surveying Profession

Today, the quantity surveying profession in South Africa is served by the South African Council for the Quantity Surveying Profession (SACQSP) and the Association of South African Quantity Surveyors (ASAQS). The Royal Institution of Chartered Surveyors (RICS) is an international governing body located in the United Kingdom that can also regulate the quantity surveying profession to South African members. The SACQSP is mainly responsible for governing the quantity surveying profession by i) implementing the Act, which includes guidelines on professional registration, legislation, education, discipline, professional conduct, and identification of work; ii) interacting with the Council for the Built Environment (CBE); iii) protection of the public; and iv) the recommendation of professional fees (Maritz & Sigle, 2012). The ASAQS, as a voluntary body, is tasked with enhancing and advocating the profession’s interests (Hauptfleisch & Sigle, 2014). It fulfils this role by offering educational materials and organizing training events (ASAQS, 2020). Equally, the RICS, an internationally respected professional organisation, caters to the global land, property, infrastructure, and construction sectors. Specifically, it oversees the quantity surveying profession worldwide, ensuring adherence to standards of conduct and competency among professional quantity surveyors (Wao & Flood, 2016).

2.5 QUANTITY SURVEYORS SERVICES, COMPETENCIES AND SKILLS

Being a professional quantity surveyor means having specific roles and responsibilities within the construction industry and even more so on construction projects. (see Appendix 5). Quantity Surveyors can be involved in construction projects as early as the inception phase. To execute services, roles and responsibilities successfully, the quantity surveyor needs specific competencies, skills, and attributes to ensure successful execution and implementation. As Nkado and Meyer (2001) highlight, the professional quantity surveyor plays a crucial role within the construction industry and the built environment, aspiring to uphold their professional status and ensure recognition of their social services. Furthermore, according to Willis, Ashworth and Willis (1994), a professional is characterized by delivering competent and integrity-driven services utilizing distinctive and refined techniques. Bennett (1991) further emphasizes that a professional is an individual who has undergone education and training to apply a specialized body of established knowledge and techniques adeptly to address practical challenges. Future quantity surveyors are trained and educated at higher education institutions, where they need to develop specific skills and competencies to fulfil their services, roles, and responsibilities within the construction industry successfully.

2.5.1 Quantity Surveying Identification of Work

Quantity surveyors offer diverse services encompassing estimating, cost advice, property development consultancy, guidance on tendering processes and contractual arrangements, financial oversight of contracts, valuation of work in progress, and creating cash flow budgets (ASAQS, 2020). Their pivotal role and significance within the construction industry are undeniable. Possessing a versatile skill set, quantity surveyors are indispensable across various stages of construction projects. They collaborate closely with various stakeholders, including architects, engineers, contractors, subcontractors, project owners, government bodies, and insurance firms, among others (Noor et al., 2020). As the Society of Chartered Surveyors in

Ireland (SCSI, 2020) highlights, quantity surveyors contribute value by managing costs effectively throughout construction. Their primary objectives are to control costs, risk mitigation, and enhancement of project value, ensuring that both design and construction phases deliver optimal value to the client. According to the SACQSP (2011), quantity surveyors are recognized as experts with specialised knowledge in construction procurement, contracts, finance and economics.

The quantity surveyor is the expert in cost and value within the construction industry, offering invaluable guidance to clients regarding the cost implications of design choices and effective management of construction expenses. Additionally, they provide recommendations on project size, standards and associated costs, facilitate budget preparation, foster collaboration with other members of the design team, oversee tender procedures and contractual arrangements and enforce financial controls during construction to ensure adherence to project budgets (Thayaparan et al., 2011; Ashworth et al., 2013; Maritz & Sigle, 2012; Shafiei & Said, 2008; Cunningham, 2014b). In addition to these standard professional services, the quantity surveyor is skilled in negotiating rates and prices with contractors, managing the financial aspects of cost-plus or lumpsum contracts, preparing BoQ for engineering work, and acting as a principal agent. Quantity surveyors are also able to value buildings for insurance purposes, interpret construction contracts, serve as expert witnesses in disputes, prepare statements for submission during litigation procedures, and participate in other forms of dispute resolutions (Maritz & Sigle, 2012). Quantity surveyors play a multifaceted role across various construction sectors, encompassing residential, commercial, industrial, leisure, agricultural, and retail domains. Additionally, they extend their expertise to diverse infrastructure projects, including roads, railways, waterways, airports, seaports, coastal defences, power generation facilities, and utilities (Cunningham, 2014b).

Modern-day quantity surveying services may range beyond traditional services, and quantity surveyors may undertake a broader spectrum of work, from proving investment appraisals to construction project managers. In addition to those above, the following specific services can also be provided by a quantity surveyor: cost planning, management, reports and analyses, project procurement, contract administration, feasibility studies, asset financial management, and final accounts, estimate the value of variations or work executed, tender evaluations and compilations of BoQ, provisional BoQ, and schedule of rates (Shafiei & Said, 2008; Cunningham, 2014b; Wao & Flood, 2016; Thayaparan et al., 2011; Yogeshwaran, Perera & Perera, 2014; Maritz & Sigle, 2012; Noor et al., 2020).

Beyond professional services, quantity surveyors also have responsibilities. One primary responsibility, whether employed by a private quantity surveying firm, a construction company, a property developer, or a large public or private organization, is the quantification of construction work. If a quantity surveyor is employed in a professional firm, they would usually be referred to as a client's quantity surveyor. In contrast to employment in a professional firm, the quantity surveyor can also be employed by a construction company or contractor where the financial interest of the contractor is the quantity surveyor's principal responsibility and the quantity surveyor would engage in matters relating to costs and estimates from an entrepreneurial perspective (Shafiei & Said, 2008). What is imperative is the responsibility or service of cost management that remains the same, irrespective of the organisation. As per Cunningham (2014b), the quantity surveyor representing the contractor is tasked with compiling accurate material requisitions, reconciling subcontractors' invoices, optimizing operational procedures for cost-effectiveness, and offering guidance to the contractor regarding contract compliance. Seeley (1999) further supports that the responsibilities of the contractor's quantity surveyor are subject to the size of the construction firm; in smaller companies, the role may entail a broader scope of duties compared to larger counterparts. Minor differences exist between employment at a professional firm and a construction company. However, in the end, quantification and measurement remain vital responsibilities and skills required by a quantity surveyor to execute the service and responsibility of cost management and control, irrespective of employment.

The SACQSP has an identification-of-work document in which the description and standard of the delivery of quantity surveying services and responsibilities are set out. This identification-of-work document is essential, as it restricts the authority of the quantity surveyor on a construction project. The services and responsibilities in Table 2.1 below as identified by the SACQSP. It is essential to note the quantity surveyor's areas of responsibility as this indicates the critical skills required to perform these services and responsibilities.

Table 2.1 SACQSP identification of work document summary

	SACQSP Identification of Work
1	Interaction with stakeholders
2	Interpreting construction drawings and specifications

3	Compilation of price determination documents
4	Taking off quantities and preparing price determination documents for simple and complex buildings
5	Implementing budgetary processes
6	Cash flow forecasting and management
7	Prepare financial reports
8	Prepare cost estimates
9	Advice on design-cost alternatives
10	Undertake project cost norm analyses
11	Prepare replacement cost valuations
12	Cost planning and cost control
13	Providing procurement advice
14	Management of payment processes
15	Identify and manage scope changes
16	Determination of resources required
17	Contractual management
18	Undertake strategic planning
19	Cost and benefit analyses
20	Economic and financial analyses
21	Contract documentation advice
22	Advice on price determination methods
23	Manage the production and preparation of price determination documentation and cost management documents
24	Resolve claims
25	Prepare final accounts
26	Apply close-out procedures

27	Develop and implement project service quality assurance procedures
28	Undertake financial feasibility studies, including market need, risk and return analyses
29	Planning and managing environmental initiatives
30	Managing and administering construction projects on-site
31	Managing construction organisational assets
32	Design, compile and utilization of project cost information databases
33	Managing the price determination, awarding and evaluation processes (tender process management)
34	Risk management
35	Undertake whole-life appraisals
36	Contribute to the sustainability assessment
37	Undertake value management exercises
38	Design and implement specialised service quality assurance procedures
39	Conduct tax assessments
40	Conduct land and related tax assessments
41	Conduct premises, energy, maintenance and assets register audits
42	Undertake professional practice management, including structuring the enterprise, negotiating quantity surveying-client agreements and applying relevant fee scales

(Adapted from SACQSP, 2011)

Table 2.1 shows that the professional quantity surveyor engages in various cost-related services on a construction project, ranging from cost planning to contractual agreements. Cost management and control are critical to the quantity surveyor as a professional consultant on the construction project.

In addition to the identification-of-work document of the SACQSP, the Council for the Built Environment (CBE) also has a scope-of-work document that stipulates the services to be performed by a professional quantity surveyor according to their standards (CBE, 2019). Once again, the scope-of-work document is essential as it demarcates the responsibilities and authority of the Quantity Surveyor on a construction project. The scope of work published by the CBE is divided according to the six stages of a construction project, as seen in Table 2.2, where inception is the first stage and the closeout phase is the sixth and last stage of construction; this presentation and division of services are the most distinct differences between the two documents.

Table 2.2: Identified Quantity Surveying Work (CBE)

Stages of Service	Professional Quantity Surveyor
Inception	Development of a clear project brief Attending project initiation meetings Procurement policy advice Advising on various other consultants and services required Define the consultant's applicable work and services Concluding the terms of the agreement with the client Advising on economic factors affecting the project Advising on the most appropriate financial design
Concept and Viability	Collaborate with the principal consultant and other consultants to agree on the documentation program. Attend design and consultants meetings. Review and assess design concepts, providing advice on viability in collaboration with other consultants. Receive data and cost estimates from other consultants. Prepare preliminary and elemental estimates of construction costs. Support the client in preparing a financial viability report. Audit space allocation against the initial brief. Maintain liaison, cooperation, and provide essential information to the client, principal consultant, and other consultants.
Design Development	Collaborate with the principal consultant and other consultants to review the documentation program. Participate in design and consultants' meetings. Assess and review design and outline specifications, ensuring effective cost control with other consultants. Collect pertinent data and cost estimates from other consultants.

	Develop detailed construction cost estimates. Aid the client in reviewing the financial viability report. Provide input on space and accommodation allowances, and prepare an area schedule. Maintain liaison, cooperation, and information exchange with the client, principal consultant, and other consultants.
Documentation and procurement	Attend meetings with design and consultants. Aid the principal consultant in developing the procurement strategy for contractors, subcontractors, and suppliers. Review working drawings to verify compliance with approved construction cost budgets or financial viability. Prepare procurement documentation for both principal and subcontractor needs. Assist in tender calls and negotiate prices alongside the principal consultant. Contribute to the financial assessment of tender submissions. Assist in preparing contract documentation for finalization and signature.
Contract administration and inspection	Participate in the site handover process Compile schedules detailing predicted cash flow. Generate proactive estimates for proposed variations to assist client decision-making. Attend regular site, technical, and progress meetings. Resolve financial claims from contractors through adjudication. Support in resolving contractual claims raised by contractors. Establish and maintain a financial control system. Prepare valuations for payment certificates issued by the principal agent. Prepare final accounts for the project works.
Close-out	Prepare valuations for payment certificates to be issued by the principal agent. Finalize the final account.

(Adapted from CBE, 2019)

From Table 2.2, it can be determined that there are various similarities and overlaps between the identification-of-work document (IdoW) presented by the SACQSP and the CBE scope-of-work. Once again, the involvement of the professional quantity surveyor in cost-related services is evident.

From the preceding literature, the following roles, services, and responsibilities of the professional quantity surveyor can be summarised and listed as follows:

- → Advice on costs, estimating, property development, tender procedures and contractual arrangements,
- → Tender evaluation and reports,
- → Contract administration and procurement,
- → Prepare Bill of Quantities (BoQ),
- → Cost management, control, planning and reporting,
- → Calculation of price fluctuations,
- → Compilation of cash flows, budgets and cost estimates,
- → Valuation of work in progress and quantification of construction work,
- → Monthly payment valuations, certificates and progress payments and final accounts,
- → Measurement and estimate value of variations,
- → Feasibility studies,
- → Asset financial management,
- → Investment appraisals,
- → Act in disputes as facilitator or witness,
- → Construction project management,
- → Negotiate rates with contractors.

These sections show that the professional quantity surveyor has a vast array of services and responsibilities to perform in the construction industry and on construction projects, which mainly involve cost management, cost advice and the quantification of construction work.

The interdependency between cost management and quantification is essential to note. Quantification of building materials is needed to calculate associated costs. If a Quantity Surveyor cannot do quantification, they cannot properly execute the service of cost control and cost management.

However, the abovementioned responsibilities cannot be executed successfully if the professional quantity surveyor is incompetent. Therefore, the required competencies and skills must also be investigated and presented with an overview. Future quantity surveyors must develop the appropriate skills and competencies to execute the services successfully.

2.5.2 Quantity Surveyor's Competencies

The quantity surveyor must have specific competencies, skills and attributes to execute the critical services, roles and responsibilities mentioned in the previous section. To further clarify these crucial aspects, one should first understand the meaning and definitions of competency, skill and attributes, respectively. In Table 2.3, definitions are presented and consolidated.

Table 2.3: Definitions relevant for this doctoral study

Competency	An important skill that is needed to do a job (*Cambridge Dictionary*, 2022)
	Noor et al. (2020:2) describe competency as the assessment of an individual's personal attributes, abilities, skills, and knowledge that enables them to perform successfully in a particular field.
	In a study by Mohammad, Hassan and Yaman (2021:15), competency encapsulates knowledge, understanding, skills, attributes, and behaviour in its definition.
Skill	An ability to do an activity or job well, mainly because you have practised it (*Cambridge Dictionary*, 2022).
	Skill can be interpreted as a subset of competencies as competence is described as the demonstration of an integration of knowledge, skill, personal attributes and value orientations (Karunasena, Niroshan & Perera, 2015).
Attribute	A quality or characteristic that someone or something has (*Cambridge Dictionary*, 2022).
	A quality, character, or characteristic ascribed to someone or something (*Merriam-Webster*, 2022)

(Source: Author's own compilation)

As depicted in Table 2.3, there are distinctive differences between competency, skill and attributes; however, they are all needed to create a highly functional professional, and the development of the needed competencies, skills and attributes is fundamental during formal education at higher education institutions.

Regarding skills and competencies for the quantity surveyor, there are many discrepancies in various classifications and definitions. There are also duplications of categorizations and overlapping definitions (Dada & Jagboro, 2012). As mentioned in section 2.4.2, the RICS is an international professional body governing the quantity surveying profession on an international level, thus for this research, the RICS list of competencies will be referred to and presented, but in essence, this research is not about the competencies required, nor the level of competencies required. The fact is that quantification of construction work is one of a professional quantity surveyor's primary responsibilities; thus, **it makes measurement a core competency**. The teaching thereof, or rather the challenges encountered in the learning and teaching of first-year students in the building measurement module, is at the heart of this research study.

The pathway and competencies defined by the RICS are the skills, knowledge and experience required to become a professional quantity surveyor (PrQS), also known as a Chartered Surveyor. The competencies are defined at three different levels. Level 1 is knowledge and understanding, level 2 is the application of knowledge, and level 3 is reasoned advice, depth and synthesis of technical knowledge and its implementation of the competencies. There are three categories of competencies: mandatory, core and optional (RICS, 2022).

The first category is mandatory competencies, which are compulsory personal, interpersonal, professional practice and business competencies. These mandatory competencies include ethics, rules of conduct and professionalism. The required level of competence is level 3, which states that the candidate must give reasoned advice and have a depth of technical knowledge. The following mandatory competencies are required on level 2, which states that the candidate must be able to apply the knowledge and understanding of client care, communication and negotiation, health and safety. There are also level 1 mandatory competencies, which include accounting principles and procedures, business planning, conflict avoidance, management and dispute resolution procedures, data management, diversity, inclusion, and teamwork, inclusive environments and sustainability. Level 1 competency requires knowledge and understanding (RICS, 2018).

The second category is core competencies. The following competencies must be achieved on a level 3 competence level such as commercial management of construction works or design economics and cost planning, construction technology and environmental services, contract practice, procurement and tendering, project finance (control and reporting), and quantification and costing of construction work (RICS, 2020).

The third category of competencies is optional, all to be achieved on a level 2. This includes capital allowances, commercial management of construction work or design economics and cost planning, conflict avoidance, management and dispute resolution procedures or sustainability, contract administration, corporate recovery and insolvency, due diligence, insurance, programming and planning, project feasibility analysis and risk management (RICS, 2020).

As indicated above, quantification and construction work costing have been listed as level 3 core competencies. Quantification indicated on a level 3 competency level indicates the importance of measurement skills for professional quantity surveyors. McDonnell (2010) supports this by mentioning that measuring quantities is a core skill for a quantity surveyor and a cornerstone of quantity surveying education. Measurement, quantification and valuation are a quantity surveyor's most distinct, important and unique competencies. Cost control, estimating, plan reading, and economics of construction are also essential competencies, as indicated in previous research studies (Crafford & Smallwood, 2007; Thayaparan et al., 2011; Cunningham, 2014b; AIQS. 2021; Yogeshwaran et al., 2014).

However, competence in a specific area is not enough, as particular skills and attributes are also needed to successfully execute the roles and responsibilities.

2.5.3 Quantity Surveyor Required Skills and Attributes

As per the definition presented in Table 2.4, skills and attributes form part of the broader definition of competence. Since the early 1930s, several authors have outlined the skills and attributes necessary for a Professional Quantity Surveyor.

In 1931, Fletcher and Bannister (in Hodgson et al. 2008) highlighted a comprehensive understanding of building construction, familiarity with standard measurement protocols, awareness of trade customs, and interpersonal qualities such as tact, patience, accuracy, and energy. Additionally, they emphasized the importance of possessing common sense, initiative, and imagination to envision intricate design details – a crucial aspect of a professional quantity surveyor's skill set. Mudd (1984, in Hodgson, 2008) proposes a range of essential skills and attributes for individuals in the field, including a solid foundation in numeracy, hands-on experience in practical settings, proficiency in reading and deciphering technical drawings, disciplined and organized work habits, adeptness in managing extensive paperwork, a curious disposition, and the confidence and adaptability to assimilate valuable information. Good organisational abilities, intuition, application and aptitude are essential skills identified by Skitmore (1985, in Hodgson et al. 2008). In 1988, Willis and Newman (in Hodgson et al. 2008) listed the following skills as important: the ability to write, be careful, think logically, and possess a sound knowledge of building materials.

In more recent sources, the SACQSP (2022) also displays in their professional registration policy document the workplace skill and experience needed for a professional quantity surveyor. The list is in addition to the RICS competency list, part of the professional registration pathway guide (SACQSP, 2020).

In the tables below (Tables 2.4–2.10), the areas of skill and experience according to a professional body (SACQSP) are presented. The required skills and experience are divided into the six stages of the construction process: inception, concept and feasibility, design development, documentation and procurement, construction, and closeout. An area of specialisation is also added to the list from the professional body.

Table 2.4: Quantity Surveyor required Skill and Experience – Stage 1

1.0	**Inception**
1.1	Developing project briefs and attending project initiation meetings.
1.2	Advising on procurement policy for the project.
1.3	Defining the quantity surveyors' scope of work and services and finalising the client/quantity surveyor professional services agreement.
1.4	Advising on economic factors affecting the project and on appropriate financial design criteria.

Table 2.4 shows the needed skills of the professional quantity surveyor during the construction process's inception phase. During the inception stage of the construction project, the quantity surveyor can advise on various economic factors and possible cost savings of the proposed concept, and they can also advise on procurement strategies. The client consultants' agreement between the client and the quantity surveyors is also finalised.

Table2.5: Quantity Surveyor required Skill and Experience – Stage 2

2.0	**Concept and Feasibility**

2.1	Agreeing on the documentation programme for the project.
2.2	Reviewing and evaluating design concepts – value engineering.
2.3	Preparing preliminary estimates of construction cost.
2.4	Assisting in the preparation of financial viability reports/feasibility studies.
2.5	Auditing space allocations against the initial brief.

In Table 2.5, the concept and feasibility phase of the construction project is depicted. In the concept and feasibility phase of the construction project, the quantity surveyor plays a vital role in determining whether the proposed project will be economically and physically feasible. The quantity surveyor also reviews concept designs.

Table 2.6: Quantity Surveyor required Skill and Experience – Stage 3

3.0	**Design Development**
3.1	Reviewing the documentation programme.
3.2	Reviewing and evaluating design and outline specifications and exercising cost control.
3.3	Preparing detailed estimates of construction cost.
3.4	Reviewing the financial viability report/auditing of Cost Budget Estimates.
3.5	Preparing area schedules and advising on space and accommodation allowances.
3.6	Advising on escalation formulae and their implementation.

According to Table 2.6 the quantity surveyor has to have specific skills during the design development phase of the construction project. Design development is mainly where the architects and the engineers are involved; however, the quantity surveyor is responsible for estimates and construction cost calculations and finalisation of the feasibility study and the estimate concerning the budget.

Table 2.7: Quantity Surveyor required Skill and Experience – Stage 4

4.0	**Documentation and Procurement**
4.1	Assisting in formulating the procurement strategy for contractors, subcontractors and suppliers.
4.2	Reviewing working drawings to comply with the approved construction cost budget and/or financial viability.
4.3	Preparing documentation for principal and subcontract procurement including the measurement and design of work, and the drafting of preliminaries, preambles and contract conditions.
4.4	Taking off of quantities and preparing price determination documents, including abstracts, schedules and pricing specialist construction elements following industry practice norms.
4.5	Preparing schedules of quantities for engineering works (civil, structural, piping and electrical) and the various methods of measurement.
4.6	Advising on the selection of tenderers.
4.7	Calling of tenders and/or negotiation of prices.
4.8	Evaluating and reporting on tenders, including clarification meetings.
4.9	Preparing contract documents.
4.10	Advising on the different forms of construction contracts available for projects (JBCC, FIDIC, NEC, GCC).
4.11	Understanding the roles, requirements and responsibilities of cost engineers and the use of cost elements (WBS).
4.12	Preparation of health and safety requirements for building projects.

The documentation and procurement phase of the construction project is one of the most essential phases to which the quantity surveyor contributes. The fourth stage is crucial for the quantity surveyor, as tender documentation is prepared during this stage, which is one of the primary responsibilities of the quantity surveyor. Measurement accuracy is vital for the successful cost calculation and final cost determination of the project. The quantity surveyor also plays a significant role in the procurement process and the evaluation of tenders.

Table 2.8: Quantity Surveyor required Skill and Experience – Stage 5

5.0	**Construction**
5.1	Attending site handover and regular site, technical and progress meetings.
5.2	Preparing schedules of predicted cash flow.
5.3	Cost control during the works' progress includes advising on proposed variations and alternative construction methods and sequencing.
5.4	Reporting on cost variations and contractual issues.
5.5	Adjudication and resolving financial claims by the contractor, subcontractors and/or suppliers.
5.6	Preparing valuations for interim payment certificates and reconciliation statements.
5.7	Measuring and recording site information for final account purposes.

Cost management and control are crucial for the quantity surveyor in the construction phase. During this construction stage, quantifying construction work and material is vital for the client and the contractor. Payment of work done is based on a valuation of the work done, and for this, quantification skills are paramount.

Table 2.9: Quantity Surveyor required Skill and Experience – Stage 6

6.0	**Close-Out**
6.1	Preparing and agreeing on final account(s) for the works.
6.2	Preparing valuations for final payment certificates and reconciliation statements.
6.3	Preparing fee accounts based on appropriate fee scale and conditions of appointment.

In the last stage of construction, the quantity surveyor's main responsibility is determining the final account and the final payment certificate. Quantification skills are also crucial in the valuation of work done to prepare the final account and determine the final payment certificate.

Table 2.10: Quantity Surveyor Required Skill and Experience (Specialisation)

7.0	**Specialisation**
7.1	Project planning and project management.
7.2	Dilapidations and maintenance.
7.3	Office management, resource allocation and budgeting.
7.4	Taxation allowances and grants.
7.5	Insurance.
7.6	Litigations and arbitration.
7.7	Insolvency and liquidation.

(SACQSP, 2020)

The compilation of skills and workplace experiences outlined in Table 2.4–2.10 underscore the critical importance of quantification skills for quantity surveyors. These skills are indispensable, as quantity surveyors engage in the meticulous measurement and quantification tasks that underpin project cost estimation and pricing forecasts. Strong quantification skills are imperative for quantity surveyors, given their integral role in various aspects of project management, such as estimating, procurement, purchasing, planning, and site management (Fortune & Skitmore, 1994).

The role of a professional quantity surveyor in construction projects is multifaceted and demanding, encompassing a broad spectrum of skills and responsibilities crucial for project success. These include financial expertise, analytical skills, effective communication, interpretive capabilities, collaboration skills, and sound decision-making. These skills are essential for making strategic decisions that greatly influence project outcomes. Additionally, proficiency across all phases of the construction process and building life cycle is paramount. This proficiency entails adeptness in cost management, maintaining a delicate balance between quality and value, and tailoring solutions to meet each client’s unique requirements. Furthermore, quantity surveyors must possess contractual and legal skills, uphold the highest standards of professionalism, exhibit innovation, quick thinking, ambition, resilience under pressure, and good negotiation skills (Cunningham, 2014b; Wao & Flood, 2016; ASAQS, 2020).

In their work, Lee, Trench and Willis (2014) describe the skills necessary for a quantity surveyor, particularly in quantification. These skills include i) the capacity to articulate thoughts clearly in a language devoid of ambiguity to prevent misunderstandings; ii) a robust comprehension of building materials and construction methodologies; iii) meticulousness and precision in performing calculations to ensure accuracy; iv) the possession of a methodical and organized mindset; and v) the capability to visualize drawings and intricate design details effectively.

In a study by Fortune and Skitmore (1994) on quantification skills in the construction industry, the authors have proposed a conceptual model of the grouped attributes of measurement skill characteristics, as presented in Figure 2.1. These attributes of measurement skill characteristics include i) technical soundness; ii) educational soundness; and iii) personal soundness. Whereas educational soundness reflects the importance of problem-solving abilities or skills, technical soundness is all about the measurer having sufficient knowledge and personal soundness is about good intellect, logical thought and numeracy skills.

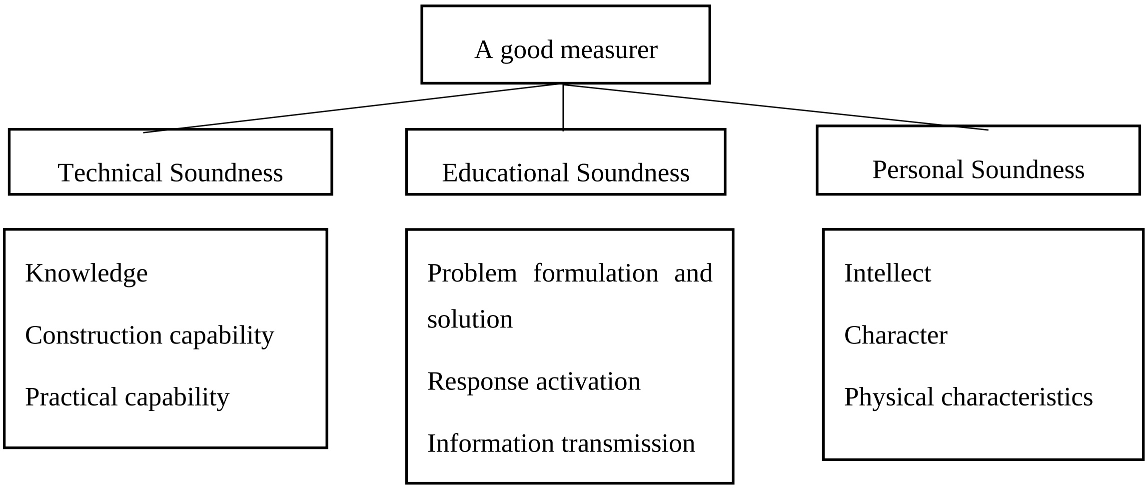


Figure 2.1: Conceptual model of the grouped attributes of measurement skill characteristics
(Adapted from Fortune & Skitmore, 1994)

2.6 QUANTIFICATION AND QUANTIFICATION PROCESS BY THE QUANTITY SURVEYOR

In their 2012 publication, Maritz and Sigle underscore the significance of various critical aspects in the measurement or quantification process. These crucial considerations are accuracy and neatness, emphasizing the meticulous and methodical approach or order applied during measurement. They highlight the necessity for a thorough understanding of building services, materials and construction technology and terminology. Additionally, Maritz and Sigle (2012) stress the importance of thoroughly knowing appropriate systems for measuring building work and accurately checking dimensions on drawings before initiating any measurement. The authors advocate using dimensions on drawings instead of scaling and emphasize the need for full referencing of all measurements for future applications. Furthermore, they emphasize the critical role of unambiguous descriptions in the measurement process. These elements collectively contribute to a comprehensive and practical approach to measuring and quantifying building-related parameters.

As seen from Table 2.6, measurement and quantification stand out as core competencies and skills requirements of the professional quantity surveyor in the construction process. Before any construction costs can be assessed or determined, the quantity surveyor needs to quantify what goes into the building project. Measurements are required for different construction or project management activities where appropriate and accurate rates can be applied to the quantities and then a cost price can be established (Lee et al., 2014). This process is also known as quantification or taking-off, which is discussed in detail in the next section. Therefore, there is a central link between design and cost and the essential processes of measurement and valuation. The BoQ preparation also involves measuring or taking-off quantities from drawings prepared by architects and engineers. Fortune and Skitmore (1994:79) explain that "measurement and quantification are well-established activities in the construction industry and their applications are well known". It is further pointed out that project cost and price forecasts heavily rely upon quantifying and measuring construction work (Hodgson et al., 2008; Cunningham 2014a; McDonnell 2010; Fortune & Skitmore, 1994).

2.6.1 Quantification, Measurement and Taking-off

Measurements or quantification can be used to compile a cost estimate of the whole (construction) project, or it can be used to compile the BoQ. Measurement, quantification, or taking-off of a proposed project can also occur in various stages, from the inception and the feasibility phase up to the close-out phase, where the final account is prepared.

The purpose of quantification is to i) establish a budget price, ii) give a pre-tender estimate, iii) provide a contract tender sum, or iv) to evaluate the amount to be paid to a contractor. The quantities are measured following a specific set of rules known as the Standard Method of Measurement (SMM). In South Africa, quantity surveyors measure according to the Standard System of Measuring Building Work (SSMBW). Various jurisdictions employ unique methods or measurement standards; nevertheless, the majority adhere to similar underlying measurement rules and principles.

Packer (1996) describes the taking-off process as extracting information from drawings by the measurer, either by reading the information from the drawing or using a scale ruler to take dimensions from the drawings. The process of measuring, quantification or taking-off involves converting information from architectural and engineering drawings and specifications into quantities and descriptions according to a strict set of rules (SSMBW). It can also be referred to as the reading of construction drawings, calculation and quantification of work and to document the quality of the work to be executed (Maritz & Sigle, 2012; Lee, 2013; Lee et al., 2014).

There are several definitions for measurement, as summarised below in Table 2.7. It is essential to understand the definition of measurement as it iterates the importance of this process as the core of the quantity surveying profession.

Table 2.11: Measurement definitions within the context of Quantity Surveying

Author	Definition
Pickens and Jagger (2005)	A process concerned with converting construction drawings into words and numbers following a strict set of rules.
Hodgson et al. (2008)	A process requiring technical knowledge and understanding of building or civil engineering technology.
Cunningham (2014a)	It involves recording dimensions and is referred to as taking-off because it involves reading or scaling (taking-off) dimensions for a drawing and entering this information in a standard manner on purpose-ruled paper called dimension paper or take-off paper.
Tunji-Olayeni et al. (2016)	Building measurement is calculation-based and requires great skill in mensuration and a good understanding of design and construction.

(Source: Author's own compilation)

Subsequently, from these definitions in the above table, the following can be concluded about measurement, quantification or taking-off.

→ Knowledge and understanding of building technology, design and construction are imperative for the quantity surveyor.

→ Reading and scaling of dimensions from drawings according to a specific set of rules.

→ Have great skill in mensuration (mensuration is the mathematical term used to describe the techniques used to determine lengths, areas and volumes (Packer, 1996).

Being competent and having the skill to measure starts with higher education and it is here where critical skills are taught and learned. Fundamental and shared in every quantity surveying programme or curriculum is the module of (building) measurement or quantification (Ayarkwa et al., 2011; RICS, 2018).

The learning and teaching aspects of quantification or building measurement are presented in the next section.

2.7 TEACHING METHODOLOGIES IN QUANTIFICATION

Learning and teaching in measurement or quantification, also known as the building measurement module, is imperative for students enrolled in a quantity surveying programme and for the continuation of the quantity surveying profession as a whole. As depicted in earlier sections of the literature, quantification is a core skill of a quantity surveyor to execute all cost-related functions (section 2.5.1 & section 2.5.3). Thus, the learning and teaching of building measurement must always be under the magnifying glass to ensure that students are adequately trained in this essential skill.

The main aim of the building measurement module is to equip students with the necessary skills in descriptive quantification, abstracting, and billing techniques and introduce students to measuring structures by applying applicable measuring methodologies according to a set of rules and guidelines. The main focus of the building measurement module at first-year level is the measurement of certain building elements and components such as foundations, ground floor construction, superstructure brickwork, internal and external finishes and roof construction. The significance of precision in measurements is highlighted by Smallwood and Cumberlege (2016). Quantities must be thorough, technically precise and effectively communicated (Cunningham, 2014b). Typically, instruction in the building measurement modules entails lecturers explaining construction technology on drawings while demonstrating the students' quantification or taking-off processes (Lee, 2013).

The building measurement module consists of four elements of theory and practice, which include 1) theories of construction technology, 2) principles of measurement and mathematics, 3) skills in taking-off, and 4) preparing, and presenting BoQ. In the building measurement module, students will further read and interpret construction drawings, measure the dimensions and write them on dimension paper, and work out the quantities (Lee, 2013). Hasan and Rashid (2005:63) indicate that measurement or quantification of construction work is one of the core courses in a quantity surveying programme that entails teaching. It entails teaching “knowledge and skills of taking-off quantities from drawings and specifications and preparing and presenting BoQ”.

As noted, construction technology is one of the four elements of building measurement theory. The importance and interdependence of building measurement and construction technology are well documented, and the understanding of building materials and methods is vital for students to measure and quantify items (Hasan & Rasid, 2005; Hodgson et al., 2008; Glick et al., 2012; Ayinde & Samuel, 2018). The student needs to understand the technicalities, building methods and materials used for construction before they can quantify it.

Learning and teaching the building measurement module does not come without its challenges for students and lecturers (section 2.7.1) focusing on challenges related to the building measurement module.

2.7.1 Learning and Teaching in Quantification

Learning and teaching of quantification have been under investigation since the early 1990s and researchers have explored and presented the various challenges experienced by students and lecturers in this module. Researchers worldwide have noted various teaching difficulties in the building measurement module; these challenges that were investigated are not limited or unique to a specific year group and are experienced throughout the quantity surveying curriculum. However, the challenges have not explicitly focused on first-year level, but have included the quantity surveying curriculum. The building measurement module is presented in the quantity surveying curriculum, usually from the first year of study until the third year and in the honours curriculum. The module is more practical than theoretical by nature. It entails using construction drawings to take measurements and specifications and quantifying the items according to a specific set of rules (section 2.6.1).

It is essential to mention that construction education has been researched well, especially construction management education, architecture, and engineering education. However, quantity surveying education is not as prevalent in research as other construction disciplines (Ostrowski, 2011).

As mentioned in Chapter 1 of this study, various challenges are experienced in the building measurement module in general. There is not much research in South Africa on these challenges in the building measurement module on the first-year level specifically. As shown earlier, it is well-known that first-year students are underprepared when entering higher education (section 2.3.1). Furthermore, research supports the fact that there are many challenges in construction education, well noted in the building measurement module; however, there seems to be a knowledge gap when the challenges of first-year students in the building measurement module are investigated, as presented in Chapter 1 Figure 1.1.

Due to the underpreparedness and poor quality of construction education first-year students and the articulation gap, students are not equipped to measure accurately, and pedagogical challenges are experienced in the building measurement module on first-year level, the teaching approach must be reviewed to support students better (Thomas & Maree, 2021; Haupt, 2009, Glick et al., 2012; Prince & Frith, 2019; Lee, 2013; Tunji-Olayeni et al., 2016; Gurmu & Mahmoon, 2020; McDonnell, 2010; Ostrowski, 2011; Hodgson et al., 2008).

The following sections show that there are many pedagogical challenges and opportunities in quantity surveying education and other related disciplines, such as architecture, engineering, and construction management, which all form part of construction education and the built environment. As noted earlier in the literature (section 2.5.1), quantity surveyors work in conjunction with other professionals in the built environment; thus, education in these professions can also be referred to as part of this investigation. However, the core of this study is the education expressly of the building measurement module on the first-year level within the quantity surveying programmes.

2.8 TEACHING CHALLENGES AND ALTERNATIVE METHODOLOGIES IN QUANTIFICATION

In the subsequent section, the challenges encountered by lecturers and students within the realm of quantity surveying education are presented, with a specific focus on the challenges within the building measurement module. These difficulties are experienced globally and extend beyond just the initial year of the curriculum (see Appendix 4). The critical gap lies in the scarcity of literature addressing the specific challenges students and lecturers face in the first year. This area of inquiry is notably underexplored. While considerable research exists on the challenges confronting first-year students in higher education and some insights into issues within the building measurement module, there is a noticeable absence of research examining the challenges encountered by first-year students specifically within this module.

2.8.1 Teaching Challenges in Quantification

Dating back almost 30 years ago, Fortune and Skitmore (1994) were concerned about acquiring quantification skills in formal education. Their research was based on the United Kingdom's construction industry. Based on their concerns, they advised and recommended that higher education move away from the formal lecture and practice sessions and incorporate teaching in a workshop environment.

Similarly, in 2005, Malaysian scholars Hasan and Rashid (2005) conducted a study examining innovative teaching methodologies within the building measurement module. They discovered that traditional teaching approaches were ineffective, particularly in imparting crucial knowledge and skills specific to building measurement. Their research highlights several challenges, including a deficiency in comprehension regarding construction technology and measurement concepts, as well as a lack of proficiency in take-off skills. Furthermore, they noted a significant disconnect between teaching construction technology, measurement principles, and practical measurement exercises. Another issue identified was the lack of alignment among the drawings utilized for measurement lectures, exercises, and coursework. To address these shortcomings, the authors propose the implementation of a measurement studio as part of innovative teaching strategies for the building measurement module in Malaysia (Hasan & Rashid, 2005).

In the UK, Hodgson et al. (2008) investigated the pedagogical challenges within the building measurement module. They emphasize the significance of students' solid understanding and knowledge of construction technology to undertake measurements and succeed in the module effectively. The authors observe that students often lack the necessary foundational knowledge of construction technology when learning measurement techniques. This deficiency in understanding building technology hampers their ability to apply measurement principles effectively, particularly by the standard measurement method. Moreover, the authors highlight the traditional teaching approach's tendency to categorize construction technology and measurement, causing frustration among students and impeding their learning progress. These findings are consistent with those of Hasan and Rashid (2005), who similarly note students' struggles in grasping construction technology and measurement concepts and deficiencies in measurement skills. The biggest challenge to teaching students measurement skills effectively is ensuring they possess adequate knowledge and comprehension of construction technology. This challenge confronts lecturers instructing measurement courses, as students often lack the prior understanding when it comes time to learn measurement techniques (Hodgson et al., 2008).

Prior understanding and the concept of prior knowledge are essential principles of learning. It is crucial to consider this principle when the pedagogical challenges of first-year students are investigated. As mentioned in the introduction of this chapter, first-year students who enter higher education institutions for the first time are underprepared and have limited prior knowledge of the construction industry and the built environment. Ultimately, this contributes to the challenges experienced by first-year students in the building measurement module. According to Ambrose et al. (2010), prior knowledge can either assist students in learning or hinder their learning.

McDonnell (2010) found that students, especially in their first year of study, find this module challenging to grasp and that their learning experience can be problematic. It is not only students who find the building measurement module a challenge; lecturers also find it a significant challenge to teach because lecturers must ensure that students have sufficient knowledge and understanding of construction technology before they can measure (Hodgson et al., 2008). The authors stress the importance of students ability to understand construction materials and technology and they need to visualize how different building components fit together to be able to measure.

McDonnel’s (2010) research in Ireland focused on the relevance of the traditional teaching approach in the measurement module to undergraduate quantity surveying students. It was found that many students find the building measurement module a challenge, especially in the first semester of their first year. Lecturers still favour the traditional teaching approach, which includes traditional manual measurement techniques; however, the efficacy of this manual method is questioned due to the computerised work environment. Senaratne and Rodrigo (2019) assert the longstanding use of the traditional taking-off format in construction. However, the authors advocate a simpler format to recognise the tediousness inherent in traditional teaching methods during the shift from manual to computer-aided measurement processes. They advocate for integrating software into measurement education, emphasizing its importance. On the contrary, McDonnell (2010) acknowledges significant learning and teaching challenges within measurement education. However, McDonnell cautions against complete computerization as a cure-all solution. Instead, he underscores the enduring value of traditional measuring techniques as essential for students to grasp fundamental principles and skills. Despite manual measurements' decreased relevance in commercial settings, McDonnell highlights its continued importance as a learning tool (2010).

In 2011, Ostrowski investigated the pedagogical challenges in the building measurement module and found that the measurement process, the calculations, technology, standard measurement method (SMM) and rulings, and speed are critical difficulties in the measurement module in the United Kingdom. He also believes that very little research on quantity surveying teaching principles has been done. In addition to the pedagogical challenges investigated by Ostrowski in the UK, Lee (2013) also investigated the challenges of teaching the building measurement module among first- and second-year students and proposed an interactive teaching approach and the use of video and interactive PowerPoint as tools to assist with the delivery of the measurement module and to support student learning. Throughout his research, it became evident that many first-year students lack the necessary skills to interpret construction drawings, let alone accurately measure and document the dimensions in a standardized format. Active classroom engagement through activities like discussions, questioning, debates, brainstorming, and reflective exercises is strongly advocated to address this challenge.

Smallwood and Cumberlege (2016) observed significant changes in the teaching methodology of the quantities module at a South African university in recent years. These changes aimed to enhance the comprehensibility of both the module's presentation and content for students studying quantity surveying and construction management. The authors investigated students' perceptions of the measurement module through their investigation. They found that while students acknowledge the importance of this module, challenges persist in its effective delivery.

Furthermore, on the African continent, Tunji-Olayeni et al. (2016) investigated learning difficulties and challenges in the building measurement module in Nigeria. Their research identified three sources of learning difficulties in the building measurement module – 1) the lecturer, 2) the lecture, and 3) the learning facilities. The teaching styles of the lecturers made comprehension difficult. Lecturers rushed through the work and assumed students possessed the necessary knowledge already. Lectures were non-interactive, and examples were insufficient and not illustrative enough for students to understand fully. A lack of exposure to software and indigenous textbooks on building measurement was identified as the learning facility source of the difficulty (Tunji-Olayeni et al., 2016). Similarly, in civil engineering measurement, the following challenges were identified: the pace of the lecturer presenting the course, the measurement or quantification process, the calculation of measurements, understanding the standard measurement methods (SMM), the taking-off sheet, and the terminology used in the measurement module seem to be a challenge (Tunji-Olayeni et al., 2021).

In 2018, Ayinde and Samuel also found challenges in quantity surveying education. They investigated the relationship between the performance of quantity surveying students in the Building Construction course and the Construction Measurement course. They found that the building construction courses support and enhance students' performance in the construction measurement courses. Thus, a comprehension and clear understanding of building construction are necessary before measuring these elements can take place. They argue that the theoretical and practical foundation offered in Building Construction courses significantly improves student performance in Construction Measurement courses.

In 2020, Gurmu and Mahmood conducted a study in Australia exploring the teaching challenges inherent in the building measurement module. Their findings illuminated a spectrum of learning obstacles students enrolled in the module encountered. These challenges included various aspects, including the effective management of group assignments, inadequate proficiency in mathematics and construction technology, constrained opportunities for practicing seminar questions due to time constraints, and the rigidity of class and seminar schedule.

Building upon this research, in 2021, Gurmu, Kamardeen and Mahmood further investigated the difficulties faced by students in interpreting building measurement concepts and procedures. Their study underscorsd students' insufficient familiarity with building technology and highlighted the limited access to essential learning materials as additional hurdles impeding effective learning.

Despite these insights, there remains a notable gap in developing a comprehensive pedagogical model tailored to address the multifaceted learning challenges inherent in the building measurement module (Gurmu et al., 2021).

The preceding section discussed the diverse challenges experienced in the building measurement module proposed alternative teaching methodologies to address these challenges (see section 2.8.2).

2.8.2 Alternative Teaching Methodologies in Quantification

In an attempt to mitigate the aforementioned (see section 2.8.1) challenges of lecturers and students in the building measurement module, it is necessary to consider if alternative learning and teaching approaches might be the answer to some of the challenges. In addition to the underpreparedness of first-year students, the lack of prior knowledge and experience in the built environment and construction industry put the students and the lecturers in a uniquely challenging position. Success in the first year is significant; not only will this determine the continuation of a student's studies, but it also has a knock-on effect on the quantity surveying profession. Therefore, alternatives to the current learning and teaching approach must be investigated. Current learning and teaching approaches, established from the limited literature, seem ineffective and do not address the challenges listed in the preceding section. The scarcity of research in quantity surveying, particularly on the challenges faced by first-year students in the building measurement module, combined with existing literature on first-year student experiences and broader issues in construction education (such as architecture, engineering, and construction management), underscores a significant knowledge gap. This gap highlights the current challenges encountered by both first-year students and lecturers in the building measurement module, which largely stem from the students' inadequate preparedness.

Chan et al. (2002) suggest that instead of adhering solely to the existing educational model, proactive measures should be taken to ensure that educational curricula are more responsive and adaptable to the evolving requirements of the built environment. There have been different efforts globally to adjust traditional learning and teaching practices. In 2018, a notable shift occurred in the educational framework of the Malaysian built environment, transitioning from a behaviourist approach to a constructivist approach. This transformation was driven by changes in teaching methodologies, learning environments, and technological innovations (Mohamed et al., 2018). Emphasizing the need for diverse teaching techniques in quantity surveying education, Leung and Chen (2008: i) underscore the significance of alternative teaching methods such as group discussions, problem-based coursework, case analyses, self-directed learning activities, project-based collaborations, and additional extracurricular engagements like study tours, summer internships, mentoring programmes, and site visits. Combined with these changes, new learning and teaching approaches have been proposed in first-year construction management education, including deep learning, flipped classrooms, and learner-centred approaches, all aimed at enhancing students' learning experiences (Sunindijo, 2016).

If alternative teaching methodologies are considered, constructivism should not be disregarded and can be seen as a viable alternative to teaching building measurement to first-year students.

2.8.3 Constructivism as an Alternative Teaching Approach

Constructivism has been a pivotal response to adapting learning and teaching styles in building sciences and construction-related disciplines. Constructivism is expanded on more in Chapter 3, but briefly refers to the ability of students to construct their learning.

Various authors advocate constructivism in construction education. Authors such as Ekundayo et al. (2021); Mohamed et al. (2018); Zulu et al. (2018); Hefer et al. (2016); Goedert and Rokooei (2016); Lee (2013); Nompunga (2013); Hartmann et al. (2010); Leung and Chen (2008) and Chan et al. (2002) promote constructivism in construction education.

The building measurement module could be viewed from a cognitivist and constructivist perspective, because students must develop the capacity and skills to learn better and construct knowledge (Lee, 2013). In their study, Smallwood and Cumberlege (2016) also cite renowned cognitivist scholar Piaget (1950, in Smallwood & Cumberlege, 2016), who believes the process by which individuals build new knowledge involves both accommodation and assimilation, drawing from their experiences. Accommodation entails incorporating new experiences into existing mental frameworks without fundamentally altering those frameworks. Nompunga (2013) references the pragmatist Dewey's notion of viewing teachers as learners, researchers and practitioners in a study on engineering education. The research findings suggest a shift from traditional teacher-centred teaching to a student-centred approach. Kelting and Hauck (2010, as cited in Goedert and Rokooei, 2016), affirm that problem-based learning (PBL) prepares graduates better for the construction industry. Hartmann et al. (2010) characterize construction management as a discipline requiring students to collaboratively solve socio-technical problems through knowledge production and sense-making; this aligns with the constructivist perspective on learning.

Learning difficulties in building measurement can be overcome by encouraging student-centred learning that encourages student participation and increases their understanding of the module (Tunji-Olayeni et al., 2016). The authors further recommend that site visits, sufficient examples, indigenous textbooks, interactive teaching, and the use of 3D drawings and videos would enhance students' learning experience.

According to Hefer et al. (2018), a contradiction exists between the traditional instructive approach and the more contemporary constructivist or student-centred approach in education delivery. While the traditional instructive method has predominated in construction education, the authors advocate adopting a constructivist approach, mainly through the utilization of a studio-based approach. Hefer et al. (2018) highlight the application of constructivism in architecture education via a studio-based teaching approach. They note that the studio-based teaching method in architecture resembles approaches found within constructivist learning models, emphasizing active student participation in knowledge construction.

Fortune and Skitmore (1994) propose that the delivery of the quantification module be changed from formal lectures to a workshop environment where more learning opportunities can be created. Hasan and Rashid (2005) also propose a studio approach for teaching measurement in Malaysia and found that it enhances students' knowledge and measurement skills.

McDonnell (2010) believes in relevance to the industry in his teaching approach in the building measurement module. His existing mode of delivery includes traditional lectures, supplemented by tutorials where students apply new knowledge gained during the lecture. The students measure quantities from drawings, giving them a flavour of the workplace. The author also supports Race (2001) and refers to shared learning experiences, learning by doing and making sense of what they already know as vehicles of learning; this is achieved in tutorial classes where manual measurement is done in groups (McDonnell, 2010). According to Chan et al. (2002), academia must embrace modern and innovative teaching methodologies, fostering a student-centred and project-based learning environment. This approach is essential for cultivating students' innovativeness, creativity and curiosity. MacFarlene (2004, cited in McDonnell, 2010) also encourages using real-life situations or problems to back up lecture material. Hodgson et al. (2008) also indicate that their approach to teaching quantity surveying includes problem-based learning. Smallwood and Cumberledge (2016) also believe in the presentation and attendance of practical sessions in addition to traditional formal lectures. Verster and Hauptfleisch (2009) propose a more practical approach towards education for construction professions due to the changing professional environment. Results from a study conducted by Sunindijo (2016) indicate that students value using real projects or cases as examples, lectures given by industry practitioners, and the inclusion of site visits into their courses.

Constructivism has emerged as a fundamental response to adapting learning and teaching methodologies within building sciences and construction-related disciplines, focusing on students constructing their knowledge, as detailed in Chapter 3. Numerous authors endorse this perspective. Specifically, the building measurement module can be viewed through cognitivist and constructivist lenses, as emphasized by Lee (2013) and supported by Smallwood & Cumberlege (2016), who reference Piaget's accommodation and assimilation concepts. Additionally, Nompunga (2013) suggests a shift towards a student-centred approach, while Kelting and Hauck (2010) affirm the benefits of problem-based learning (PBL) in preparing students for the construction industry. Encouraging student-centred learning, as recommended by Tunji-Olayeni et al. (2016), through methods such as site visits and interactive teaching can alleviate learning difficulties.

2.9 CHAPTER SUMMARY

In this chapter, foundational learning and teaching concepts within higher education were presented, specifically focusing on the challenges faced by first-year students who often enter higher education underprepared. The transition from secondary school to university poses significant hurdles for these students, largely due to shortcomings in the schooling system's ability to adequately prepare them for higher education. Upon entering higher education, first-year students in the quantity surveying programme encounter notable pedagogical challenges, particularly within the building measurement module, a cornerstone of the curriculum from the first to the fourth year. This module equips students with essential skills for executing daily responsibilities and delivering critical services as professional quantity surveyors. Unfortunately, students and lecturers encounter difficulties in learning and teaching associated with this module, worsened by the initial lack of preparedness among first-year students entering higher education. Exploring alternative teaching methodologies becomes imperative to support these students and enhance their learning experiences. Constructivism emerges as a promising approach within construction education, warranting deeper examination alongside other prominent learning theories and approaches in the subsequent Chapter 3.

CHAPTER 3
THEORETICAL FRAMEWORK
CONSTRUCTIVISM AND VYGOTSKY'S THEORY OF SOCIOCULTURAL DEVELOPMENT

3.1 INTRODUCTION

As presented in Chapter 1 and Chapter 2, various challenges have been recorded internationally in the learning and teaching of the building measurement module. To support first-year students better, make the transition from secondary education into higher education more manageable, and ultimately enhance their learning experience in the quantity surveying course, first-year lecturers of the building measurement module should investigate and adopt alternative teaching approaches such as a constructivist approach. As stipulated in Chapter 2, various studies have been undertaken to suggest constructivism as a teaching approach in construction education (Fortune & Skitmore, 1994; Christodoulou, 2004; Hasan & Rashid, 2005; Leung & Chen, 2008; Hogson et al., 2008; McDonnell, 2010; Ostrowski, 2011; Glick, et al., 2012; Lee, 2013; Tunji-Olayeni, et al., 2016; Goedert & Rakooei, 2016; Paul et al., 2019; Gurmu & Mahmood, 2020). Some authors expressly endorse the implementation of constructivism in quantity surveying education specifically (Mohamed et al., 2018; Hefer et al., 2018; Hartmann et al., 2010; Haupt & Harinarain, 2015; Zulu et al., 2018).

This chapter will provide an overview of some prevalent learning and teaching theories and approaches in higher education, such as behaviourism, humanism, cognitivism, and social learning. Then, the focus will shift specifically to constructivism as a learning approach. Furthermore, in this chapter, I will argue for and justify applying Vygotsky's theory of sociocultural development with specific reference to scaffolding and the zone of proximal development (ZPD) in possible teaching interventions to first-year students in the building measurement module. The chapter will conclude with the possibility of applying and using Vygotsky's theory of sociocultural development to enhance quantity surveying education at first-year level with specific reference to the building measurement module.

3.2 LEARNING THEORIES AND APPROACHES

Learning theories endeavour to explain how humans acquire knowledge and aid comprehension of the complex nature of learning (Muhajirah, 2020). Learning theories explain the learning process, and while they may not offer direct solutions, they highlight the pivotal variables essential for creating solutions (Hunt and Chalmers, 2021; McLeod, 2003). Furthermore, these theories can be seen as a compilation of concepts or fundamental principles used to interpret events, facts, or perspectives and can also serve as a framework for direct actions (Thompson & Spenceley, 2020). It is important to note that when choosing a learning theory or when content should align with a theory, it is all about the learning process, achieving the stated outcomes in the best possible way and the learners' best interests (Hunt & Chalmers, 2021).

The next section presents an overview and discussion of the following learning approaches: behaviourism, humanism, cognitivism, social learning and constructivism. These five broad approaches, each comprising several theories are commonly observed in higher education settings.

3.2.1 Behaviourism

Behaviourism suggests that behaviours result from learning through observation of others or reinforcement for specific actions. Central concepts within behaviourism include modelling, conditioning, and reinforcement. Modelling involves the behaviour of a model serving as an example to be imitated. At the same time, conditioning occurs when the conditioned stimulus is presented before the unconditioned stimulus, eliciting the desired response, which is then repeated until the conditioned stimulus alone is sufficient to elicit the response. Reinforcement is reinforcing or strengthening a desired behaviour through repeated actions and outcomes (Maphalala, 2016).

Behaviourism, as conceptualized by different scholars, offers a multifaceted understanding. Maphalala (2016) portrays it as the observable transformation in behaviour, emphasizing the iterative process through which new behavioural patterns become automatic. Similarly, Ahmad, Sultana and Jamil (2020) define behaviourism as a mechanical process wherein stimuli are associated with responses, ultimately leading to the emergence of novel behaviours. Nagowah and Nagowah (2009) outline behaviourism as an approach to learning solely focused on objectively observable behaviours, disregarding mental processes. Conversely, Hunt and

Chalmers (2021) assert that behaviourism revolves around meticulously observing and measuring behavioural changes. Finally, Merriam and Cafferella (1999, in Ashworth et al., 2004) characterize behaviourism as a perspective attributing personality and behaviour to environmental factors. They emphasize that learning is demonstrated through behavioural alterations, elucidating the intricate link between stimuli and responses.

Behaviourism can thus be defined as a psychological perspective that attributes personality and behaviour to environmental factors, emphasizing observable transformations in behaviour resulting from stimuli, focusing on associating stimuli with responses and measuring changes in behaviour while disregarding internal mental processes.

Pavlov (1849–1936) was famous for his classical conditioning theory, which was further developed by Watson (1878–1958) through the extension of Pavlov's classical conditioning theory. Skinner (1904–1990) also contributed to behaviourism by introducing reinforcements to behaviour conditioning, whereas Thorndike (1874–1949) discovered instrumental conditioning. Positive rewards and negative sanctions exemplify how behaviour can be shaped and reinforced towards the desired outcomes. This notion that behaviour can be moulded and guided through teacher interventions has significant implications for the power dynamics within the learning environment (Hunt & Chalmers, 2021; Ahmad et al., 2020; Maphalala, 2016). Also among the most notable behaviourism theorists is Benjamin Bloom, who investigated how targeted behaviours, termed learning outcomes, could be categorized based on levels of increasing cognitive complexity. Bloom's taxonomy, introduced in 1956, continues to be widely utilized across various educational levels and remains highly pertinent for educators today (Hunt & Chalmers, 2021).

In behaviourism, learning is identified by observable changes in behaviour. It suggests that information is transmitted from a knowledgeable teacher to a learner, who then reacts to specific stimuli. While this perspective may be perceived as overly simplistic and mechanistic, numerous principles of behaviourism remain applicable in educational settings (Maphalala, 2016). As stated by McLeod (2003), the strength of this framework lies in its capacity to generate quick solutions to well-defined issues.

The benefits of behaviourism as a learning theory lies in its direct approach to addressing behaviour, whether desirable or undesirable. Emphasizing rewards promptly reinforces desired behaviours and places importance on observable behaviours and outcomes (Maphalala, 2016).

Ahmad et al. (2020) note that this approach is typically convenient, fosters responses to predictable behaviour, and allows for easily quantifiable success.

The limitations of behaviourism include its primary emphasis on observing changed behaviour and its focus on stimuli that trigger desired responses, known as conditioning. Furthermore, learning under behaviourist theory is viewed as one-dimensional and mechanical, characterized by a teacher-centred and outcome-based approach Hunt and Chalmers (2021) and Cherry (2022).

This theory may have limited utility, particularly in the context of the building measurement module, as the repetition of behaviour to the point of automaticity is not conducive to acquiring skills and behaviours that are less predictable and applicable in this particular module. Given its predominantly teacher-centred nature, behaviourism is deemed less suitable for teaching modules like the building measurement module, especially at the first-year level.

3.2.2 Humanism

Humanism emerges from counselling psychology and focuses on developing individuals' emotions, attitudes, values, and interpersonal abilities. Humanist perspectives lean towards philosophy rather than empirical research, as humanism prioritizes the individual, allowing them to determine the relevance of content and their learning objectives (Bates, 2019). Thompson and Spenceley (2020) point out that humanism, as a teaching theory, is widely used but not fully understood. Many teachers aim to teach more than just subject matter – they want to help students become well-rounded individuals who can contribute to society. Hence, humanism in teaching means teaching knowledge and skills and helping students understand themselves so they can reach their full potential and make a difference in the world.

Maslow is a pioneer in humanistic theory, which suggests that individuals inherently strive for self-actualization and engage in learning for their intrinsic worth, as highlighted by Hunt and Chalmers (2021) and Muhajirah (2020). In addition to Maslow, Rodgers is acclaimed for his contributions to experiential learning, emphasizing teachers' role in facilitating meaningful participation and empowering learners. This approach, primarily targeting adult learners, stresses the importance of creating a supportive learning atmosphere that resonates with learners' interests while safeguarding their self-concept from threats (Hunt & Chalmers, 2021). Kolb's influential experiential learning model, characterized by the cycle of experience, reflection, conceptualization and experimentation, further solidifies incorporating personal experiences into the learning journey (Hunt & Chalmers, 2021).

While humanism places significant emphasis on the content aspect of the learning process, it tends to idealize learning and teaching beyond practicality. In essence, it prioritizes an idealized notion of learning rather than reflecting the realities of everyday learning experiences, as highlighted by Muhajirah (2020). According to McLeod (2003), behaviourism-based learning, including rote learning, lacks integration into an individual's cognitive framework, making it prone to being quickly forgotten. Hence, this approach adopts a person-centred approach.

This approach may offer limited practicality for first-year students and lecturers engaged in the building measurement module. While educators aspire to instil knowledge and skills and foster holistic student development, this theory could benefit such endeavours. However, its reliance on rote learning and the absence of cognitive integration may present challenges within the context of the building measurement module, where deeper understanding and application are paramount.

Recognizing the importance of different learning approaches within the building measurement module holds significant importance. For instance, behaviourism contributes significantly to skill development practice. At the same time, experiential learning models like Kolb's are crucial for engaging in site visits and hands-on tasks involving tools such as scale rulers. Additionally, prior knowledge is pivotal in both behaviourism and cognitivism, where exposure and experience aid in fostering familiarity. Likewise, cognitivism underscores the significance of forming mental frameworks, known as schemas, as a foundational step in understanding new concepts.

3.2.3 Cognitivism

Cognitivism is a learning approach that focuses on the mental processes involved in learning. It emphasizes how individuals perceive, organise, store and retrieve information. Cognitivism suggests that learning involves not only the acquisition of new information but also the restructuring of existing cognitive frameworks to accommodate new knowledge.

Cognitivism investigates the internal mental processes of the learner during the learning process. Cognitivism also involves viewing learning as an active internal mental process, enhancing mental capacity and skills to facilitate improved learning outcomes (Nagowah & Nagowah, 2009, McLeod, 2003). Similarly, Bates (2019) defines cognitivism as a principle where information is actively processed within the mind, with behaviour modification stemming from exploring relationships among various pieces of information. Bates (2019) further compares cognitivism to assembling a jigsaw puzzle, where individual pieces lack meaning until interconnected to other pieces to form a coherent whole, illustrating the synthesis of information in cognitive processes.

While Good and Brophy (1990) outline behaviourist concepts such as contiguity, repetition, and reinforcement, emphasizing the latter's role in providing feedback rather than solely acting as a motivator, cognitive theorists also acknowledge these principles. However, they perceive learning as the acquisition or restructuring of cognitive frameworks responsible for processing and retaining information. In essence, cognitivism involves actively processing information within the mind, seeking relationships among different pieces of information, akin to assembling a jigsaw puzzle to create a coherent understanding.

Therefore, cognitivism directs its attention to the internal mental processes of learners, interpreting learning as the acquisition or restructuring of cognitive frameworks for processing and storing information, ultimately resulting in improved mental capabilities and skills.

John Dewey and Jean Piaget were pioneers in the field of cognitive development. Piaget observed that children undergo distinct stages of growth, each characterized by unique ways of perceiving, interpreting, and deriving meaning from their experiences. Cognitivists assert that learners acquire knowledge by receiving, storing, and retrieving information, as McLeod (2003) notes.

Cognitive theories provide frameworks that help us understand the mental processes associated with learning and their complexities. These theories propose that cognitive skills mature sequentially, with development occurring in different stages, believed to vary from one individual to another. Each person has a predetermined growth rate for various functions, including cognitive development (Maphalala, 2016).

3.2.4 Social Learning

The essence of social learning lies in the idea that individuals learn from observing and interacting with others within their social environment. This learning process is not solely dependent on personal experiences or direct reinforcement but is greatly influenced by social interactions, modelling, and the shared experiences of others. Social learning theory emphasizes the importance of social context, relationships, and cultural factors in shaping behaviour and learning outcomes. It recognizes the role of peers, mentors, family members, and broader societal influences in transmitting knowledge, values, norms, and skills. Ultimately, social learning highlights the interconnectedness between individuals and their social environments in the learning process.

Social learning is founded on the principle that interpersonal interaction is integral to development. Bandura suggests that behaviours are acquired through specific observations. Bandura introduces the concept of social modelling, whereby learning occurs through observing influential figures, such as teachers, in a classroom setting. Both positive and negative behaviours can be acquired through these observations (Thompson & Spenceley, 2020). Maphalala (2016) asserts that Bandura's contributions to understanding and development are noteworthy, mainly through his social cognitive learning theory formulation. This theory revolves around observational learning, wherein individuals acquire knowledge and skills by observing others being rewarded or punished, even if they do not directly experience the consequences themselves.

Merriam and Caffarella (1999, in Ashworth et al., 2004) categorize social learning theory among other educational theories such as constructivism, humanism, behaviourism, and cognitivism. Nonetheless, some scholars disagree with this classification. Tennant (1997, in Ashworth et al., 2004) proposes that social learning theory encompasses a range of theories and approaches, characterizing it as the "social environment" perspective. This theory has sparked debates regarding the degree of learner involvement in the learning process, with two contrasting perspectives emerging, one emphasizing active learner participation and the other highlighting a more passive role.

The importance of social interaction in the learning process underscores the relevance of this theory. However, mastering the building measurement module solely through social interactions is insufficient; achieving optimal learning outcomes necessitates a more excellent cognitive balance.

3.2.5 Constructivism

The essence of constructivism lies in the belief that individuals actively construct their understanding and knowledge of the world through their experiences, interactions, and reflections. Instead of passively receiving information, learners engage in sense-making activities, interpreting new information in light of their existing knowledge and mental frameworks. Constructivism suggests that learning is a dynamic process of meaning-making, where learners build upon their prior knowledge and experiences to construct new understandings and perspectives. Additionally, constructivism recognizes the social and cultural contexts in which learning occurs, acknowledging the influence of social interactions, collaboration, and dialogue in shaping individual learning paths.

Constructivism is a process where learners actively forge meaning through engagement with their experiences and environment, underscoring the learner-centric nature of the learning process (Ashworth et al., 2004). This approach is deeply rooted in humanity's innate drive to comprehend the environment. In constructivist learning, dynamism and participation are key, with learners continuously integrating previous experiences and knowledge into their understanding, as Kerka (1997) highlights. McLeod (2019) identifies three primary branches of constructivism: cognitive constructivism (attributed to Piaget), social constructivism (associated with Vygotsky), and radical constructivism (linked to Von Glaserfeld). Noteworthy is the profound influence of constructivism on educational and learning methodologies, shaping the perspectives of theorists such as Dewey, Piaget, Rogoff, Vygotsky, Boud, Candy, Von Glaserfeld, and Illeris. Social constructivism underscores the active involvement of students in constructing their understanding, with significant emphasis placed on social interaction among peers. In contrast, cognitive constructivism prioritizes knowledge construction through processes like assimilation or accommodation (Ahmad et al., 2020).

Hence, constructivism is a learning approach wherein learners actively construct meaning through engagement with their experiences and environment, emphasizing the learner's central role in learning. Rooted in the innate human drive to understand the environment, constructivist learning is characterized by dynamism and participation, with learners continuously integrating previous experiences and knowledge.

Dewey, Piaget, Vygotsky and Bruner are groundbreaking figures whose works have paved the way for the contemporary understanding of constructivism (Mensah, 2015). While Piaget is associated with social learning and cognitivism, Vygotsky is particularly linked with social learning. A key distinction between social learning and constructivism lies in their approaches: social learning emphasizes interaction and observation within a social context, whereas constructivism focuses on learners constructing meaning from their experiences, regardless of whether this happens through social interactions.

The acceptance of constructivism as a conceptual framework gained traction in the late 20th century through practical application. Constructivism is actively creating knowledge instead of passively internalizing information acquired from others or the environment. According to Kurt (2011), learners should be considered active individuals seeking meaning. The experiences of the individual, as well as their relations to the environment, contribute to the knowledge construction; active participation by the individual is paramount in this theory. Educators must understand the pre-existing knowledge that learners bring into the learning environment, thereby guiding the learning process and supporting students in constructing and developing their knowledge (Sawyer, 2014; Ashworth, et al., 2004; McLeod, 2003).

The advantages of constructivism are that the learning process is active and learning activities are based on real-life problems or scenarios (Ahmad et al., 2020). The disadvantage of constructivism as a learning theory is that individual experiences and success can vary (Ahmad et al., 2020).

3.2.6 Summarised preceding learning approaches

This overview of the various learning approaches, as presented in the preceding sections (3.2.1–3.2.5), aims to help the reader form a comprehensive understanding of this intricate subject, focusing on the approaches themselves, notable theorists, critical attributes of the theories, and their suitability for teaching within the building measurement module are presented in this summary below.

Table 3.1: Learning Approaches Summary

Approach	**Theorists**	**Attributes**	**Suitability for the Building Measurement Module teaching**
Behaviourism	Guthrie, Hull, Thorndike, Watson, Pavlov, Skinner, Tolman, Gagne, Engelmann	Observable changes in behaviour, controlled environment, stimulus and response, reward and punishment, rote learning, person-centred, reactive learner, limited emotions	Limited utility in the Building Measurement module due to rote learning. Understanding of drawing, principles and rules is necessary.
Humanism	Maslow, Rodgers,	Focuses on the development of emotions,	Partially applicable to the Building Measurement Module

	Montessori, Neill, Knowles, Mezirow	values, attitudes and interpersonal skills	to student development, however, there is a lack of cognitive interaction.
Cognitivism	Bruner, Piaget, Ausubel, Gagne, Koffka, Kohler, Lewin, Vygotsky, Bandura	Processing and organising new information with pre-existing schema, pro-active learner, memory and organization, rehearsing info, limited creativity	Applicable to the building measurement module, however, active engagement is lacking.
Social Learning	Bandura, Vygotsky, Piaget, Boud, Rotter, Engestrom, Eraut, Lave, Wenger, Salomon	Observing of behaviour, modelling and social interaction.	Social interaction is important in the learning process of the Building Measurement Module. However, more cognitive engagement is necessary for learning in the building measurement module.
Constructivism	Dewey, Piaget, Rogoff, von Glaserfeld, Vygotsky, Boud, Illeris, Candy	Constructs knowledge through past experiences and collaboration, the learner is pro-active, real-world problems, participation and engagement, socializing, and not all have prior knowledge.	Constructivism seems appropriate for learning in the building measurement module, mainly due to active engagement with lecturer and peers and the construction of own knowledge.

While Table 3.1 reveals that all five learning approaches have some degree of applicability in the learning and teaching of the building measurement module, upon closer examination, it can be concluded that constructivism is particularly well-suited for quantity surveying education, as supported by previous research (Chapter 1; Mohamed et al., 2018; Hefer et al., 2018; Hartmann et al., 2010; Haupt & Harinarain, 2015; Zulu et al., 2018).

The subsequent section will present the specifics of this learning theory as a possible alternative teaching approach in the building measurement module on the first-year level.

3.3 CONSTRUCTIVISM: A SUITABLE APPROACH FOR THE BUILDING MEASUREMENT MODULE

The core concept of constructivism lies in the notion that students need to discover and adapt intricate information to various situations, ultimately internalizing it as their own thus placing students at the forefront and giving them the agency to guide and supervise their learning journey. This shift in focus redefines the role of the lecturer as that of a coach or facilitator rather than solely a provider of information. Constructivist learning settings are characterized by incorporating various representations of reality and theoretical concepts (Muhajirah, 2020; Ashworth et al., 2004). In the constructivist perspective, knowledge is not perceived as a commodity to be passively transmitted to students; rather, it is regarded as something individuals actively build for themselves. Students create knowledge by connecting new information with their prior experiences, adjusting their mental frameworks to assimilate new information (Thompson & Spenceley, 2020).

Constructivism has different perspectives on reality, experience, knowledge, and how meaning is created. For tertiary-level students, they need to focus on both individual and social aspects of learning. This focus involves acquiring skills, participating in collaborative learning, employing creative problem-solving strategies, facilitating guided discovery and reflecting on their experiences (Merriam and Caffarella, 1999; Ashworth et al., 2004). Examples of constructivist learning manifest in experiential learning, self-directed learning, and reflective practice. These learning approaches underscore the pivotal role of students in actively constructing knowledge within a social framework (McLeod, 2003). Some of these learning and teaching approaches have been investigated and found appropriate for construction education, specifically in the building measurement module as discussed in previous sections of this study (Chapter 1 and section 3.2.6).

Constructivism mandates the active engagement of individual students in the learning process. Furthermore, it demands that teachers relinquish some of their traditional authority within the classroom, transitioning from the role of the knowledgeable instructor to that of a facilitator, thereby shifting the responsibility for learning onto the students themselves (Thompson & Spenceley, 2020). These authors further assert that learning and teaching constructively is challenging for both the students and the teachers as it requires both to change their relationship with the learning process. Shifting from the conventional role of the teacher as a pedagogue, who dictates both the information imparted and its reception in the learning process, to that of a guide and mentor, fostering students' self-directed understanding poses a challenge.

Constructivist learning encompasses several vital characteristics as listed below.

1. Firstly, it involves facilitating learning experiences that connect existing student knowledge, fostering learning by actively forming new knowledge.
2. Secondly, it emphasizes providing diverse learning opportunities, recognizing that problems can have multiple solutions and encouraging exploration of different approaches.
3. Thirdly, it integrates learning into realistic and relevant contexts, utilizing concrete experiences to grasp concepts within the framework of everyday life.
4. Additionally, constructivist learning promotes social interaction and collaboration, facilitating the exchange of ideas between individuals and fostering cooperative learning environments.
5. Utilization of various media, including oral and written communication is also central to this approach, enhancing the active engagement of learners.
6. Finally, emotional and social involvement is prioritized, aiming to create an exciting learning environment where students are motivated and eager to participate in the learning process (Muhajirah, 2020).

It is essential to understand the characteristics of constructivist learning, because it allows one to comprehend its nature and possible applications and implications.

McLeod (2003) explores the core principles of constructivism, articulating that knowledge is actively constructed rather than passively absorbed, marking a departure from traditional views of learning. He emphasizes the dynamic nature of learning, portraying it as an active process wherein individuals engage with and manipulate information to construct meaning. Furthermore, they further underscore the social dimension of knowledge construction, highlighting that social interactions and contexts inherently shape all knowledge. Additionally, he asserts the personal nature of knowledge, suggesting that individuals interpret and internalise information through their unique perspectives and experiences. Ultimately, McLeod positions learning as an intricate interplay within the mind, emphasizing its existence as a cognitive process that unfolds through personal and social interactions.

Consequently, prior knowledge, various teaching techniques, real-life problems, active learning, communication, and student-centred learning are the key characteristics of constructivism. The rationale behind including this overview of prior knowledge, as opposed to other elements of constructivism, stems from its particular significance to the core of this research study. While prior knowledge is briefly addressed within the constructivist framework, its specific relevance warrants a more detailed examination. In the quantity surveying programme context, prior knowledge is not a mandatory component. However, given the programme's affinity with fields like medicine and accounting, students often possess foundational knowledge from related modules studied previously. Conversely, in the case of quantity surveying, there is a notable absence of compulsory or prerequisite modules directly aligning with the programme's core or, more specifically, the building measurement module.

3.3.1 Prior Knowledge: An Element of Constructivism

As already stipulated (section 3.3), prior knowledge is integral to this constructivist learning approach. Educators often strive to enhance students' understanding of course material by fostering connections between the content and their existing knowledge and experiences, whether derived from prior sections of the same course, previous academic pursuits, or everyday life (Ambrose et al., 2010). Incorporating and synthesizing prior knowledge with new insights and understanding significantly enhance learning. Acknowledging that the evolution and expansion of existing knowledge are vital aspects of the learning process (Fry et al., 2009) is crucial. As Ausubel (1968, cited in Harland, 2003:266), aptly notes, "The most important single factor influencing learning is what the learner already knows", underscoring the profound influence of prior knowledge on the learning experience. Prior knowledge serves as the foundation upon which new knowledge is built. A common misstep observed among educators in higher education is initiating instruction from their level of understanding rather than meeting students at their current level of knowledge. Effective teaching necessitates acknowledging and incorporating students' prior knowledge, as disregarding it undermines the efficacy of the educational process (Gabriel, 2008).

It is crucial to recognize that not all previously acquired knowledge is a sturdy foundation for acquiring new insights. When prior knowledge is inadequate or irrelevant, it has the potential to distort students' grasp of concepts, hindering their comprehension. Misconceptions and inaccuracies stemming from prior knowledge can significantly impede students' ability to learn new material effectively (Ambrose et al., 2010). While prior knowledge often serves as a valuable asset in acquiring new information, there are instances where it may prove inappropriate, inadequate or erroneous, thereby hindering the learning process (Davis & Arend, 2013). Therefore, it is imperative to determine the prior knowledge of students (Gabriel, 2008).

Assessing students' prior knowledge upon entering the course is essential, as it empowers educators to tailor instruction more effectively. This proactive approach enables lecturers to harness students' existing knowledge more efficiently, facilitating learning and pinpointing areas for improvement (Ambrose et al., 2010).

Students often do not spontaneously link new information to relevant prior knowledge. Hence, it becomes imperative for lecturers to engage actively in stimulating or activating students' prior knowledge during lectures (Ambrose et al., 2010). Facilitating this process of activating prior knowledge is crucial. It can be achieved through various small teaching interventions aimed at assisting students in making meaningful connections between what they already know and the new content being presented. By gauging their level of understanding, lecturers can identify any misconceptions or inaccuracies, allowing them to intervene promptly and guide students towards a deeper and more accurate comprehension of the subject matter (Ambrose et al., 2010). Various methods exist to assess the extent and characteristics of students' prior knowledge. These include engaging in discussions with colleagues to gain different perspectives, administering diagnostic assessments tailored to evaluate students' existing understanding comprehensively, and prompting students to self-assess their prior knowledge through structured reflection activities. Additionally, techniques such as brainstorming sessions can be employed to uncover and explore students' pre-existing knowledge collaboratively. Assigning concept mapping tasks visually represents the interconnectedness of students' existing knowledge. Furthermore, analysing student work for recurring patterns of misconception or error offers valuable insights into their prior knowledge (Ambrose et al., 2010).

Several strategies can be employed to activate prior knowledge effectively. Firstly, engaging in exercises designed to elicit students' existing knowledge can serve as a foundation for further learning. Secondly, explicitly connecting new material to concepts previously covered in other courses can help students contextualize and integrate their learning. Similarly, making explicit connections between new content and prior knowledge within the current course can enhance students' comprehension and retention. Additionally, utilizing analogies and examples rooted in everyday experiences enables students to relate new information to familiar contexts. Lastly, prompting students to apply relevant prior knowledge in their reasoning processes encourages deeper engagement and reinforces connections between concepts (Ambrose et al., 2010). Despite accurate prior knowledge, it frequently remains dormant and necessitates activation.

Therefore, educators must determine their students' existing knowledge and prompt them to recall what they already understand (Davis & Arend, 2013).

The premise suggests that for students to learn effectively, they must forge links between new knowledge and their existing comprehension. Yet, the success of this process depends on both the nature of students' prior knowledge and the lecturer's ability to utilize it effectively (Ambrose et al., 2010). Students experience improved learning and retention outcomes when they connect new information with their pre-existing knowledge. In most information-processing scenarios, individuals strive to comprehend the content being processed, drawing upon their existing knowledge to derive meaning. Prior knowledge significantly influences the efficiency and fluency of the processing task, as it directly influences how quickly and effortlessly individuals can make sense of the presented information (Davis & Arend, 2013).

The primary justification for advocating the application of Vygotsky's theory in the first-year building measurement module stems from its foundation in constructivism. This framework has been studied extensively and proven effective in construction education. However, what distinguishes Vygotsky's theory is its incorporation of a crucial element known as scaffolding. This concept holds significant potential for enhancing the teaching methodology, particularly for underprepared first-year students in the building measurement module. In the next section, Vygotsky's theory is presented and discussed.

3.4 VYGOTSKY'S THEORY OF SOCIOCULTURAL DEVELOPMENT

Emphasizing the importance of language and collaborative learning, Vygotsky's theory of sociocultural development posits that cognitive development is fundamentally shaped by social interactions and cultural context.

3.4.1 Vygotsky's Theory

Lev Vygotsky was a prominent Soviet psychologist who introduced the sociocultural theory, which underscores the pivotal role of social interaction in cognitive development. Although he formulated his theory in the 1920s and passed away in 1934, it was not until the late 1950s that his work was translated and made widely accessible. According to his theory, learning is not an isolated process, but unfolds through active engagement in socially and culturally enriched experiences. Vygotsky emphasized that individuals' thinking and understanding are profoundly shaped by their interactions with others and the environment within meaningful contexts. Interaction with individuals with greater knowledge significantly influences cognitive development. Vygotsky argued that social interaction is the primary catalyst for intellectual development (Van der Stuyf, 2002; Vygotsky, 1978).

Vygotsky made significant contributions to human intelligence, developing various theories, including those of social construction and the zone of proximal development. He posited that humans possess an innate inclination to engage socially, and children learn through action and social interaction. The social environment plays a vital role in influencing learning, with a critical component being the interaction between teachers and learners, as well as among learners and language, as highlighted by Maphalala (2016).

Vygotsky's theory underscores that social interaction comes before development, and consciousness and cognition arise as outcomes of socialization and social behaviour (Roman, 2016; Sawyer, 2014; Wass & Golding, 2014; Van der Stuyf, 2002). Verenikina (2003) emphasizes that Vygotsky's theory builds upon Piaget's idea of the child as an active learner, emphasising the crucial role of social interaction in both learning and development. This framework is termed social constructivism, highlighting the collaborative creation of knowledge through interpersonal engagement.

Vygotsky proposed that the social connections with family, friends, teachers and peers influence cognitive abilities and understanding. He created the term 'more knowledgeable others' (MKOs) to represent these individuals who serve as sources of learning. Furthermore, Vygotsky introduced the concept of scaffolding to describe the educator's role in facilitating interaction and fostering development within the zone of proximal development (ZPD). Additionally, he introduced the concept of the ZPD to characterize the environment where learning takes place through social engagement. Within the ZPD, learners participate in activities with guidance and assistance, enabling them to grasp concepts that exceed their current level of comprehension (Bates, 2019).

However, Vygotsky's theory has certain shortcomings that researchers must acknowledge. According to Ameri (2020), a key weakness of the theory lies in its emphasis on child development within social contexts, which places more focus on learning through social interaction than on the individual's cognitive development.

The diagram below (Figure 3.1) illustrates the core principles of Vygotsky's theory, highlighting the vital role of social interaction, language and cultural context in cognitive development. Central to this theory is the concept of the ZPD, where learners operate with guidance and support. Through interactions facilitated by MKOs and the incorporation of technology and tools, students navigate their ZPD, progressing from an initial inability to independently perform specific tasks towards achieving autonomy. Scaffolding activities play a pivotal role in this progression, enabling learners to bridge the gap between what they can do with assistance and what they can achieve independently.

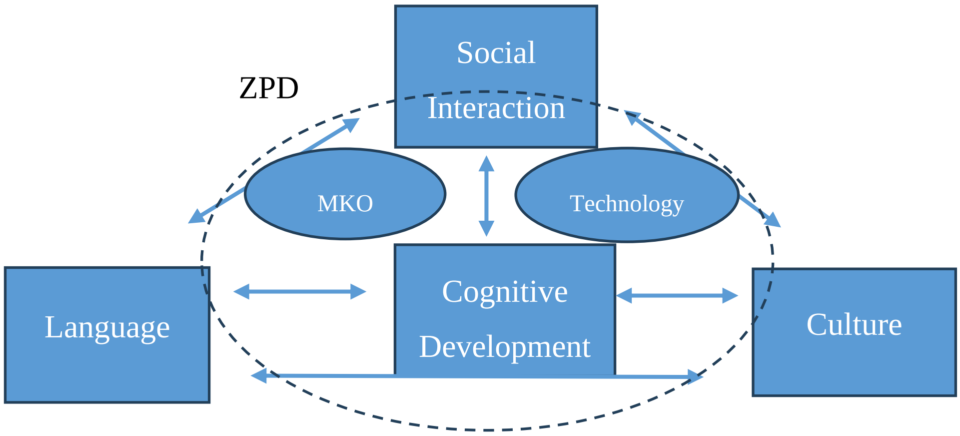


Figure 3.1: Elements of Vygotsky's Theory (Author's own design)

The upcoming sections (3.4.2–3.4.5) will explore the components of Vygotsky's theory in more detail, exploring their significance and implications. These components encompass the More Knowledgeable Other (MKO), language and scaffolding. The subsequent sections will introduce and examine each, explaining their roles in facilitating the learning process.

3.4.2 More Knowledgeable Other (MKO)

The concept of the MKO is fundamental to Vygotsky's theory, particularly in the ZPD (McLeod, 2018). The MKO can be defined as someone with a better understanding or a higher ability level than the learner with a specific reference to a task or concept. MKOs can be teachers, older adults or peers. Thompson and Spenceley (2020) highlight Vygotsky's assertion that a student may assume the role of an MKO during interactions with peers possessing advanced or diverse understandings of a subject. In this capacity, the student functions as a critical friend, challenging and expanding existing schemas for their fellow students. Collaborative learning with a peer with slightly more advanced skills enhances learning and cognitive development (Maphalala, 2016).

3.4.3 Language

In Vygotsky's theory, language holds immense significance as a tool for cognitive development. According to Vygotsky (1986), language reflects and shapes our thinking processes. It serves as a means for communication, social interaction, and internal thought. Through language, individuals can share and negotiate meaning with others, influencing their understanding of the world. Additionally, language enables individuals to internalize knowledge and regulate their behaviour through self-directed speech. Vygotsky outlines two pivotal functions of language in cognitive development: firstly, as the primary means through which adults convey information to children, and secondly, as a powerful tool for intellectual development. Within this context, Vygotsky identifies three specific forms of language: social speech, which entails communication with others externally; private speech, marked by self-directed discourse; and silent inner speech. The role of language in scaffolding must not be underestimated and is crucial for cognitive development (McLeod, 2018; Verenikina, 2003). Vygotsky posited that language catalyses cognition, implying that any educational approach fostering literacy holds paramount importance in constructing knowledge (Thompson & Spenceley, 2020; Vygotsky, 1986).

3.4.4 Scaffolding

Scaffolding originated from the construction realm. It was conceptualized by Wood, Bruner and Ross (1976) as a metaphorical tool to explain how children can undertake tasks of greater complexity with the guidance of a more knowledgeable individual. This concept entails that through support and shared problem-solving with a knowledgeable mentor, children can surpass their capabilities and tackle tasks that would typically exceed their independent capacity (Sawyer, 2014). Cazden (1979, in Van de Pol, Volman & Beishuizen, 2010) suggests expanding the original concept of scaffolding applied between a child and parent to the domain of student-teacher.

According to Wood, Bruner and Ross (1976, in Smit, Van Eerde & Bakker, 2013), scaffolding is defined as the process that empowers a child or novice to tackle a problem, execute a task, or attain a goal that would otherwise exceed their unaided capabilities. It can be viewed as a means of supporting the development and learning of children and young individuals, wherein teachers or peers furnish students with the necessary tools for learning (Rasmussen, 2001; Jacobs, 2001, in Verenikina, 2003).

The teaching strategy known as scaffolding finds its roots in Vygotsky's sociocultural theory and the concept of the ZPD (Smit et al., 2013). Vygotsky proposed that practitioners could utilize scaffolding techniques to guide individuals in navigating challenges and reaching an understanding that surpasses what they could achieve independently (Bates, 2019). The main idea of scaffolding is to share the work between the learner and the more knowledgeable other. When the learner receives a task that is more complex than what they could handle alone the more knowledgeable other would support the learner, enabling the performance of the task and enabling learning from the experience (Sawyer, 2014).

Scaffolding encompasses a range of instructional methods to guide learners step by step towards deeper comprehension and ultimately foster greater autonomy in their learning journey (Maphalala, 2016). Scaffolding denotes the pedagogical approach where educators offer cognitive aids to students at the outset of their learning journey, gradually withdrawing them as students acquire enhanced mastery and sophistication. Various forms of scaffolding have been identified to enhance students' metacognitive abilities (Ambrose et al., 2010). This instructional strategy encompasses diverse methods to systematically guide learners towards profound comprehension, thereby nurturing autonomy in their learning trajectory (Maphalala, 2016). Anticipating the scaffolding requirements for students to master the content effectively can begin well before the lesson commences. By acknowledging the likelihood of students arriving with varying levels of understanding, there is proactive preparation to address these potential knowledge gaps. The approach is rooted in proactive measures to equip students with the necessary support and resources to comprehend new material seamlessly (Rollins, 2017).

Scaffolding encompasses any instructional aid, intervention, or planning designed to facilitate the learners' engagement throughout a learning experience (Murray & Arroyo, 2002). The aim is to assist the learner in gradually attaining competency and performing a specific task independently (Smit et al., 2013). These scaffolds may take various forms, including models, cues, prompts, hints, partial solutions, think-aloud modelling, and direct instruction (Van Der Stuyf, 2002). However, it is essential to manage scaffolding cautiously to avoid over-reliance and hindrance to independent thinking (Fry et al., 2009: 21).

A crucial element of scaffolding instruction is its temporary nature. As the learners' abilities advance, the support provided by the more knowledgeable other is gradually phased out until the learner can independently complete the task or grasp the concepts (Van der Stuyf, 2002). Smit et al. (2013) reinforce this concept, defining scaffolding as the temporary assistance a teacher provides to aid a learner in tasks they cannot yet accomplish alone. Instructional scaffolding involves teachers offering temporary structures or frameworks to help students progress to the next level (Davis & Arend, 2013).

The MKO offers support or scaffolds to facilitate learners' development in scaffolding instruction. These scaffolds aid students in building on prior knowledge and incorporating new information effectively. The activities included in scaffolding are intentionally set just beyond the learners' current capabilities. By providing scaffolds, the MKO enables learners to achieve tasks with assistance they could not manage independently (Van der Stuyf, 2002). Scaffolding improves instruction by offering conceptual, procedural, strategic, and metacognitive support, helping students transition from what they can do independently to what they can achieve with guidance from a more knowledgeable person (Belland, Walker, Olsen & Leary, 2015).

The scaffolding teaching approach typically involves the following stages: establishing the teaching scaffold, engaging in the scaffolding scenario, conducting independent research, engaging in collaborative learning, and assessing the learning outcomes (Ying, Haixia, Junwei, Hongyuan & Chao, 2019). Engaging the student, fostering the building upon prior knowledge and the formation of new knowledge, and providing positive feedback serve to motivate students and minimize frustration levels. However, scaffolding can be time consuming, and its full effect may not be observed if not implemented correctly. In such cases, the teacher must relinquish some control and permit students to make mistakes (Van der Stuyf, 2002).

Following Bates (2019), scaffolding is underpinned by several fundamental principles. First and foremost, it emphasizes the importance of building interest in the subject matter and actively engaging with the students. Secondly, scaffolding advocates breaking down complex tasks into smaller, more manageable sub-tasks. However, it is essential to maintain sight of the overarching goal while completing these sub-tasks. Additionally, scaffolding encourages using more knowledgeable others for support and guidance (Bates, 2019).

Scaffolding encompasses several vital characteristics. Firstly, it offers clear direction, minimizing confusion among students. Secondly, it elucidates the purpose behind tasks, aiding students in comprehending the significance of their work. Thirdly, it ensures students remain focused on the assigned task. Additionally, it establishes clear expectations, integrating assessment and feedback mechanisms such as examples, rubrics, and standards of excellence from the outset. Moreover, scaffolding directs students towards credible sources, mitigating confusion, frustration, and time wastage. Ultimately, it diminishes uncertainty, surprise and disappointment within the learning process (McKenzie, 2000).

To classify an event as scaffolding, specific criteria must be fulfilled. Firstly, it should empower learners to complete tasks beyond their abilities. Secondly, scaffolding should guide learners towards proficiency, enabling them to independently handle similar tasks. Lastly, there should be clear evidence of learners achieving higher levels of independent competence due to the scaffolding process. These criteria collectively encapsulate the essence of scaffolding in educational contexts, highlighting its role in fostering learner development and autonomy. Mercer and Fisher (1993, in Verenikina, 2003). assert that concerning the ZPD, the primary aim of scaffolding is to transfer task responsibility to the student.

Haruehansawasin and Kiattikomol (2018) differentiate between hard scaffolding and soft scaffolding. Soft scaffolding refers to collaboration and interaction among the learners or between the teacher and the learner. ‘Hard’ scaffolding refers to static support or tools such as worksheets.

Providing excessive support is unnecessary. ‘Normally’, scaffolding is slowly phased out, allowing students to develop confidence and succeed as their assistance decreases with their progress (Rollins, 2017). This support is referred to as ‘scaffolding’, while the process of reducing it is termed ‘fading’ (Murray & Arroyo, 2002).

3.4.5 Zone of Proximal Development (ZPD)

The ZPD is one of the most recognized concepts within Vygotskian sociocultural psychology and can be fully comprehended only within the context of and as an integral part of Vygotsky’s theory (Verenikina, 2003). Numerous research studies have explored Vygotsky’s theory, yielding a range of definitions, illustrated in Table 3.2.

Table 3.2: ZPD definitions

Authors	Definitions
Vygotsky (1986)	"The discrepancy between a child's mental age and the level he reaches in solving problems with assistance indicates the zone of his proximal development."
Roman, et al. (2016:30)	"The conceptual space between what students know and what they need to know."
Van de Stuyf (2002:2)	"The distance between what children can do by themselves and the next learning they can be helped to achieve with competent assistance."
Cole and Cole (2001, cited in Verenikina, 2003:n.p.)	"As the distance between what a person can do with and without help. The term proximal (nearby) indicates that the assistance provided goes slightly beyond the learner's current competence, complementing and building on their existing abilities."
Davis and Arend (2013:53)	"The space between what a student can accomplish without help and what they need help to accomplish. It is in this zone were learning occurs."
Murray and Arroyo (2002:1)	"The distance between the actual development level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or collaboration of more capable peers', also known as the MKO."

Thus, according to the definitions in Table 3.2, it becomes apparent that a disparity exists between a learner's independent capabilities and what they can accomplish with assistance from a competent peer, often referred to as the MKO. The diagram below illustrates this range: from the zone where a student struggles to perform a task alone, through the zone where assistance from an MKO enables task completion, to the zone where the student achieves autonomy in task performance. The intermediate space between the first and third zones is termed the ZPD (see Figure 3.2).

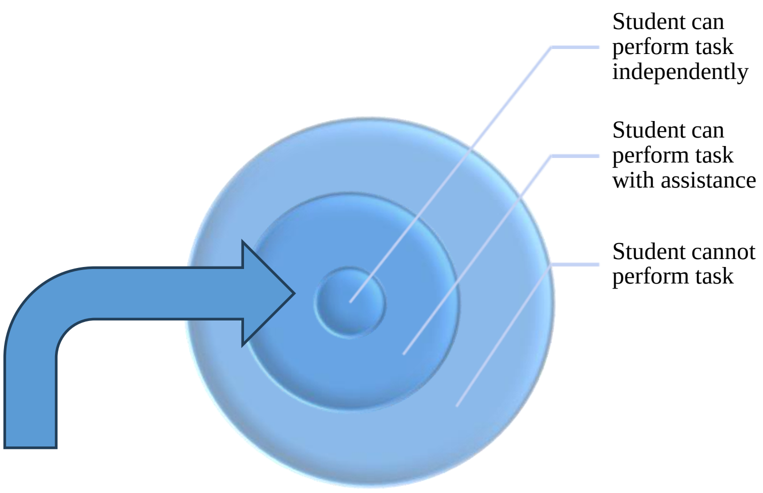


Figure 3.2: Zone of proximal development (Source: Author’s own design)

As highlighted in Figure 3.2, several strategies can be employed to establish the ZPD. Firstly, assessing learners’ prior knowledge or understanding of the subject effectively engages with them, providing a starting point for further exploration. Encouraging group members to share their experiences fosters a collaborative learning environment, enriching discussions and facilitating knowledge exchange. Breaking down the main task into smaller sub-tasks helps to alleviate the daunting nature of complex assignments, making them more manageable for individuals to tackle. Moreover, challenging learners to step beyond their comfort zones involves actively listening to the experiences of others, identifying relevant insights, and adapting and incorporating this information to enhance their understanding of the subject matter. Lastly, emphasizing the importance of each individual’s contribution to the learning process reinforces a sense of shared responsibility and encourages active participation in knowledge sharing and dissemination. These strategies collectively support the establishment of the ZPD, facilitating meaningful learning experiences and promoting intellectual growth among learners (Bates, 2019).

Teachers effectively engage with the ZPD by introducing concepts beyond students’ current skill and knowledge levels. This approach stimulates students’ motivation to surpass their existing abilities. Learners benefit from guided and supported learning activities, facilitating the construction of new knowledge through interactions and guidance provided by the teacher (Van der Stuyf, 2002). From a cognitive standpoint, it is crucial to ensure that the material is appropriately challenging – neither too simple nor overly complex. Additionally, regarding affective outcomes, the content should avoid inducing boredom, frustration, or confusion in students, as these factors can diminish motivation (Murray & Arroyo, 2002). Effective interventions within the ZPD must be grounded in diagnostic assessments that accurately gauge a learner's current level of development (Shabani, Khatib & Ebadi, 2010).

The ZPD is not solely inherent to the learning environment or the individual student; instead, it emerges from the dynamic interaction between the two. A student is considered within the ZPD when they exhibit proficient and productive learning outcomes (Murray & Arroyo, 2002). This interaction underscores the importance of collaborative efforts between students and educators in knowledge and skill construction (Verenikina, 2003). Harland (2003) emphasizes the significance of critical reflection in advancing and navigating through the ZPD, highlighting its pivotal role in the learning journey.

Ensuring the right level of challenge is crucial: Students are more likely to sustain their motivation when faced with tasks that align with their abilities. Learners may develop negative expectations and disengage if a challenge exceeds their skill level. Conversely, when challenges are reasonable, students are inclined to hold positive expectations for success, enhancing their perseverance and dedication to achieving the goal (Ambrose et al., 2010). Educators strive for students to achieve independence and self-regulation in learning and problem-solving by utilizing scaffolding as a teaching strategy (Van Der Stuyf, 2002). Vygotsky speaks of the importance of teaching learners at the appropriate difficulty level. It is not too easy or difficult (frustration level) but a middle level that the learner can accomplish with assistance (Maphalala, 2016).

An individual's advancement within the ZPD can be gauged through a comprehensive analysis encompassing pre-tests, task execution, and direct communication (Murray & Arroyo, 2002). Vygotsky's insights underscored that the space between autonomous action and assistance from others delineates various stages of development (Shabani et al. 2010). In the instructional process, learners progress from mere observation of experts to gradually tackling increasingly challenging components of tasks until they can independently execute the entire task proficiently (Murray & Arroyo, 2002).

In the preceding sections, I presented Vygotsky's theory, elucidating its core components like the MKO, language, scaffolding, and the ZPD. These elements collectively constitute the essence of the theory and are crucial for its practical application. Each concept plays a pivotal role, contributing significantly to the overarching framework of Vygotsky's theory.

3.5 CHAPTER SUMMARY

This chapter presented the theoretical framework underpinning the research study. At its core, the study is rooted in constructivism as a learning theory. The advocacy for Vygotsky’s theory of sociocultural development, which is situated within a constructivist approach, is central to this research, especially regarding its application in learning and teaching in the building measurement module at the first-year level. While constructivism has demonstrated success in construction education overall, this study advocates explicitly for its implementation for underprepared first-year students entering higher education. Leveraging elements of constructivism, such as scaffolding and the ZPD, this study aims to employ a practical approach through a case study (see Chapter 6) to assess their effectiveness in addressing the challenges faced by first-year students and lecturers in the building measurement module. The subsequent chapter will outline the research methodology adopted for this study.

CHAPTER 4
RESEARCH METHODOLOGY

4.1 INTRODUCTION

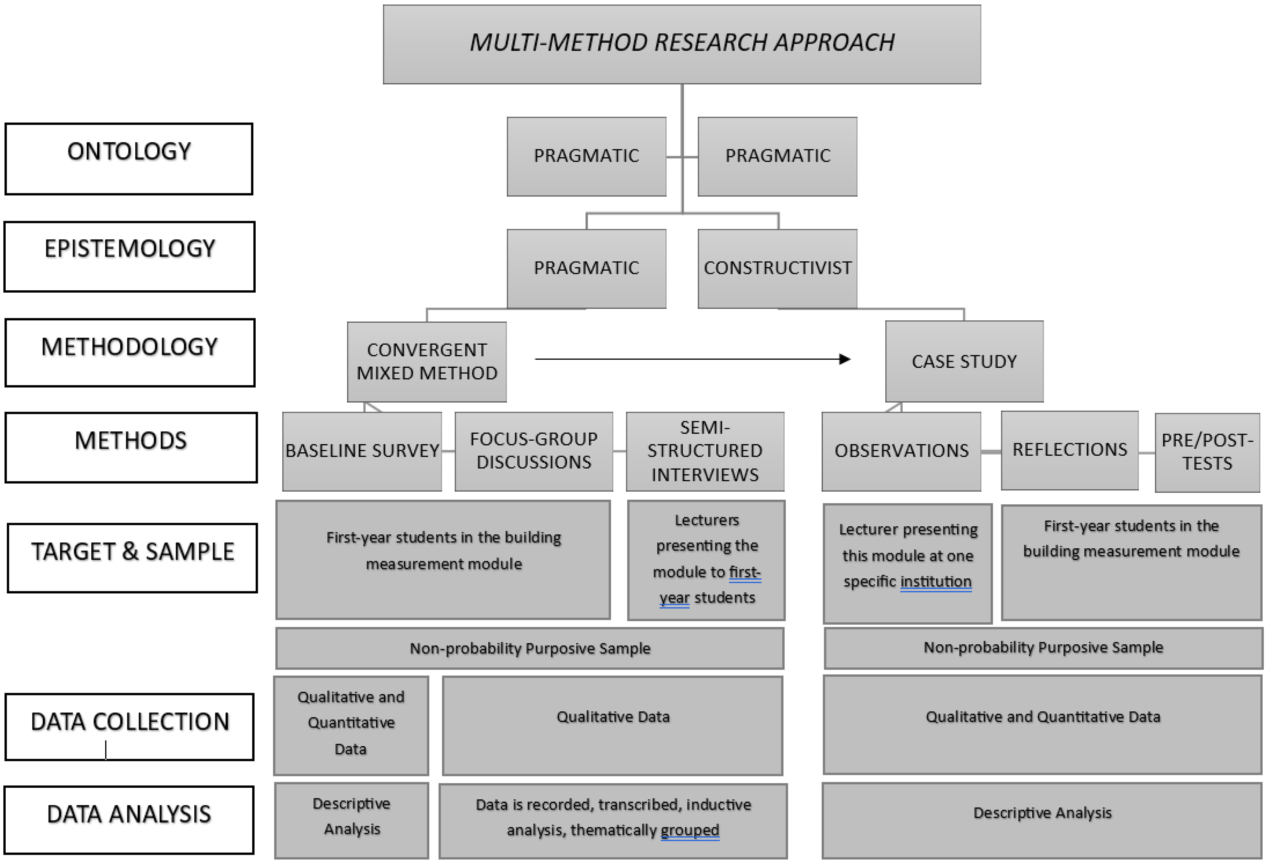
The research methodology chapter forms the backbone of the study, as it indicates the overarching research approach and design to collect and analyse the data needed to answer the research questions and reach the stated objectives of the study. As discussed in Chapter 1, several pedagogical challenges in the building measurement module, but due to the lack of contextual knowledge of the pedagogical challenges among first-year students specifically, it is necessary to implement two methodologies for this study. The first methodology primarily investigates challenges experienced by first-year students and lecturers in the building measurement module at South African universities (see Chapter 5). After the challenges are determined, the second methodology, the case study, can investigate and determine if a constructivist teaching approach, with specific reference to Vygotsky's theory of sociocultural development, would solve some of these challenges (see Chapter 6).

The lack of contextual knowledge and literature on the pedagogical challenges among first-year students and lecturers in South Africa drove the following main research question: How can first-year students' learning and teaching in the building measurement module be enhanced through a facilitation framework? The research sub-questions this study aims to answer are:

1. What is the extent of the preparedness level of first-year quantity surveying students in terms of prior knowledge or lack thereof to deal with the building measurement module content?
2. What is the nature of the challenges associated with the learning and teaching of first-year quantity surveying students in the building measurement module in South Africa?
3. What are the current approaches and techniques used in the learning and teaching building measurement for first-year quantity surveying students in South Africa?
4. What is the perceived effectiveness of the current learning and teaching approaches and building measurement for first-year quantity surveying students in South Africa?

To answer these research questions, the study followed a multi-method research approach, as depicted in Figure 4.1. Understanding the complex approach used in this research study was essential before delving into the literature. It is crucial to refer to Figure 4.1 below throughout this chapter, as it encapsulates the multifaceted and intricate multi-method research approach.

Figure 4.1: Multi-method research approach (Source: Authors' own)



This study draws from two paradigms, namely the pragmatic and the constructivist research paradigms illustrated in Figure 4.1. The pragmatic paradigm informs the first methodology, where a convergent mixed-method design will be followed. Data collection occurred by means of a baseline survey, focus-group discussions, and semi-structured interviews. The data obtained from the baseline survey, the focus-group discussions, and the semi-structured interviews were used to inform the second methodology, the case study, which drew from the constructivist paradigm. The case-study design involved qualitative and quantitative data collection with an in-depth investigation into a specific cohort of first-year students to answer the research questions and reach the stated objectives ultimately.

The research concept is defined and explained in the first part of the chapter, followed by an overview of research paradigms, designs, and approaches in sections 4.2 and 4.3, respectively. Target population and sampling, data collection and data analysis are presented as an overview in section 4.4. In section 4.5, the research methods and data collection instruments are presented. Research quality aspects are discussed, followed by ethical considerations and a discussion on the researcher's positionality in the last section of this chapter (sections 4.9 and

4.10). In each section and subsection of this chapter, a literature review is provided for the particular concept and relevant concepts relevant to this study are presented.

4.1.1 Research Defined

Research involves integrating experiential insights with logical reasoning. It entails a continuous cycle of collecting, analysing and interpreting data. This systematic approach reveals new knowledge and a more profound understanding of the issue (Kumar, 2014; Leedy and Ormrod, 2021; Shah and Al-Bargi, 2013; Bourke, 2014). Research is furthermore characterized by a structured framework guided by specific philosophies and methodologies aimed at ensuring validity and reliability throughout the process. It is essential for researchers to maintain an objective and unbiased stance throughout their entire research journey. The essence of research is the commitment to systematic, controlled, valid and rigorous exploration and description of the unknown. Bertram and Christiansen (2015) add that research endeavours entail systematically collecting empirical data or evidence to substantiate findings, as research is seen as an inquiry into reality. Research cultivates logical and rational thinking and encourages individuals to evaluate various aspects of their daily situations critically. Research also facilitates the understanding and formulation of guidelines for best practices in a particular area and is ultimately responsible for advancements in a profession; research and practice are inseparable, with ongoing advancements being imperative. The research process urges practitioners to observe, question, explore, test and comprehend different facets of their fields (Kumar, 2014).

Research can thus be characterized as a continuous and systematic process marked by the researcher's unbiased and objective stance. It operates within a structured framework dedicated to exploration and relies on empirical evidence, fostering the development of critical and rational thinking skills.

The following section presents and discusses an overview of the various research paradigms. It is important to give an overview of the research paradigms and follow the most appropriate paradigm as it guides the researcher's approach and influences how the research is interpreted and presented.

4.2 RESEARCH PARADIGMS

A paradigm in research serves as a conceptual and methodological framework that guides the research process and contributes to the consistency and rigor of scientific inquiry. Bertram and Christiansen (2014) assert that the selected paradigm influences how data are collected, the types of questions used, observations and investigations, and the approach to data interpretation. Thus, the paradigm will determine how meaning will be constructed from the data. It holds essential significance for the study in terms of the methodology and methods used it can also indicate the trustworthiness of the research. Kivunja and Kuyini (2017:26) describe a paradigm as 'the lens through which the researcher looks at the world'.

The four fundamental elements of a research paradigm, as presented in Figure 4.2, are epistemology, ontology, methodology and axiology. Epistemology addresses the question of 'how we know what we know', while ontology is concerned with interpreting the gathered data. Ontology explores the fundamental nature of reality, whereas epistemology examines the methods by which we attain knowledge and comprehend what we know (Creswell & Clark, 2011). The methodology in this study consists of the research design, methods and approaches used in the study. Axiology focuses on the important ethical considerations in the research process, encompassing privacy, accuracy, property and accessibility (Kivunja & Kuyini, 2017).

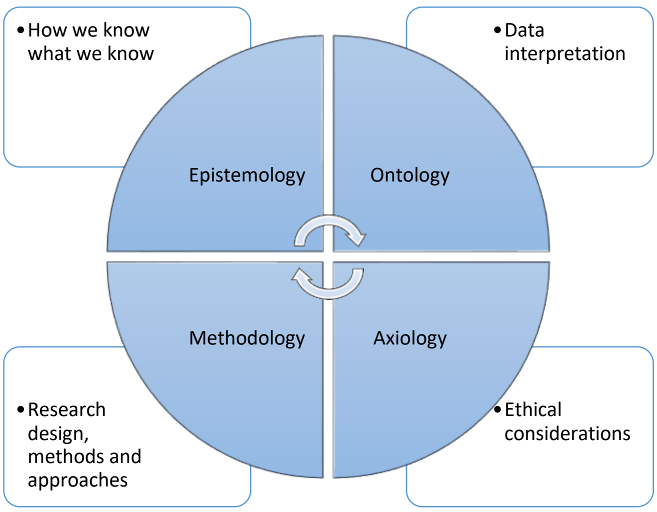


Figure 4.2: Components of Research Paradigms (Source: Authors' own)

These four fundamental elements, epistemology, ontology, methodology and axiology are discussed in the subsequent sections of this chapter. In education research, the positivist paradigm, constructivist paradigm, pragmatic paradigm and critical paradigm are prevalent (Bertram & Christiansen, 2015; Kivunja & Kuyini, 2017; Shah & Al-Bargi, 2013). Each of these paradigms will be briefly discussed next as it deems fit and appropriate to the field of study.

4.2.1 Positivist Paradigm

The positivist paradigm revolves around experimentation and observation, mostly relying on reason. It is primarily classified as a scientific method, focusing on explanations and predictions rooted in measurable outcomes (Shah & Al-Bargi, 2013; Kivunja & Kuyini, 2017). Bertram and Christiansen (2015) support this and note that evidence is not enough; it must be measurable evidence. Positivist researchers assert the existence of an external reality with distinct patterns and order waiting to be discovered. Their conviction in an external world drives them to affirm the presence of relationships between entities, which they believe can be quantified. The primary means of gathering evidence in this paradigm are observations and experiments (Bertram & Christiansen, 2015).

4.2.2 Constructivist/Interpretivist Paradigm

This paradigm is concerned with understanding the environment and individuals within the environment and their interpretations thereof – knowledge is, therefore, socially constructed within this framework (Kivunja & Kuyini, 2017). In their work, Bertram and Christiansen (2014) expand on the purpose of interpretivism, which aims to enhance the comprehension of how individuals navigate and interpret their living and professional environments. These authors further define the aim of interpretivism as seeking to understand the social world. Leavy (2017) describes this worldview of constructivism or interpretivism as the active construction and reconstruction of knowledge through daily interactions and experiences – also referred to as the social construction of reality. Interpretivists argue that quantitative research methods are insufficient for understanding social phenomena instead, they advocate diverse qualitative techniques, where the human element is emphasized as the primary research instrument (Shah & Al-Bargi, 2013).

To summarize, there is no single reality. Individuals create reality. This paradigm is suited for the present study, and the case study draws specifically from this paradigm.

4.2.3 Pragmatic Paradigm

The pragmatic paradigm revolves around the idea that resolving problems necessitates using the most appropriate methodology rather than relying solely on one scientific method. This means multiple methodologies may be required to investigate a problem effectively (Kivunja & Kuyini, 2017). Leavy (2017) observed a significant characteristic of this paradigm, indicating that various tools may be helpful in diverse contexts, regardless of a fixed set of rules or theories. Pragmatism has also been described as a perspective where knowledge is derived from examining problems and determining what is most appropriate in a specific situation (Lodico, Spaulding & Voegtle, 2006). It is essential to discover and investigate solutions that can achieve the desired outcomes, irrespective of whether there is a single or multiple realities. Research within the pragmatic paradigm usually adopts a mixed-method approach, whereby qualitative and quantitative data collection methods are used. To summarize, reality is what is useful. The pragmatic paradigm is also well suited for this study, where various tools are used to find answers.

4.2.4 Critical/Transformative Paradigm

The transformative or critical paradigm is primarily used to address issues of social justice, particularly those involving political, social, or economic factors that contribute to social oppression, conflict, and struggles. Within the critical paradigm, reality is perceived as shaped by various social, political, cultural and economic dynamics. As a result, knowledge about the world is seen as subjective, influenced by one’s specific position in society and different values. Furthermore, research in the critical paradigm aims to emancipate people by bringing about changes in their social, political and cultural contexts (Kivunja & Kuyini, 2017; Bertram & Christiansen, 2014; Shah & Al-Bargi, 2013).

4.2.5 Positioning of the current study within paradigms

As depicted in Figure 4.1, the research paradigm aligns with a pragmatic epistemological philosophy, reflecting the belief that reality keeps changing. The ontological philosophy selected for this study is also based on the pragmatic nature of reality, because it is believed that knowledge should be examined with the best available tools. The essence of a pragmatic research paradigm lies in its practical orientation towards addressing real-world problems and generating knowledge. As discussed earlier in Chapter 1 of this study, literature about pedagogical challenges on the first-year level in the building measurement module is missing; therefore, these challenges must be determined and investigated. This paradigm values flexibility, adaptability and a problem-solving approach, often integrating quantitative and qualitative methods to comprehensively understand complex phenomena. Researchers within this paradigm aim to produce relevant, applicable, and beneficial knowledge. Thus, the essence of a pragmatic research paradigm lies in its commitment to practicality, utility and the pursuit of solutions to real-world challenges.

Furthermore, this study will adopt an epistemological constructivist philosophy in the second research approach, where the data obtained in the first methodology inform the second methodology, the case study. The ontological philosophy selected for this study is based on the pragmatic nature of reality, because it is believed that knowledge should be examined with the best available tools. The essence of a constructivist research paradigm lies in its focus on understanding and interpreting subjective realities constructed by individuals or groups within specific social and cultural contexts. In this paradigm, individuals see knowledge as actively constructed based on their unique perspectives, experiences, and interactions with the world around them. Researchers within this paradigm often employ qualitative methods such as interviews, observations, and document analysis to explore complex social phenomena and understand the meanings attributed to them by participants. Overall, the essence of a constructivist research paradigm is to uncover and make sense of the diverse perspectives and realities that shape human experiences.

4.3 RESEARCH DESIGN AND APPROACH

A research design serves as a comprehensive plan outlining the methods and procedures for conducting research. It specifies both the tasks to be executed and the methodologies employed throughout the process. Kumar (2014) also stresses the significance of choosing a research design that is valid, workable, and manageable to ensure the success of the research endeavour. There is a caution against the potential pitfalls of employing an inappropriate research design, which can lead to misleading findings.

This study adopted a multi-method research approach to compensate for the lack of contextual literature regarding learning and teaching in quantity surveying, especially challenges among first-year students in the building measurement module. The initial methodology employed a convergent mixed-method design to explore experiences with learning and teaching. In contrast, the subsequent methodology, a case study, was chosen to assess the efficacy of scaffolded learning in supporting learning within the building measurement module. Data obtained from the first-year baseline survey, the semi-structured interviews with the first-year lecturers, and the focus-group discussions with first-year students will inform the second methodology, the case study, as discussed and presented later in this chapter.

Various mixed-method designs are available, including convergent design, explanatory sequential design, exploratory sequential design, experimental design, social justice design, and multistage evaluation design. In the next section, the various mixed-method approaches are presented as it is relevant to this study. This study employs a convergent mixed method in the first methodology and a case-study design in the second approach, as depicted in Figure 4.1.

4.3.1 Mixed Method

Mixed-method research uses the strengths of both quantitative and qualitative research methods, selecting the most appropriate method, regardless of whether it is qualitative or quantitative (Kumar, 2014). Kumar (2014) emphasizes the compelling nature of combining quantitative and qualitative methods, recognizing that it involves diverse and additional knowledge about different research approaches. Creswell and Guetterman (2019) highlight that applying both forms of data provide a better understanding of the problem than using just one method. In mixed-method research, qualitative and quantitative data are collected, analysed and interpreted to integrate the data into a cohesive whole (Leedy & Ormrod, 2015). Creswell and Guetterman (2019) affirm the significance of integrating data through merging, connecting, explaining, and embedding the data to gain a comprehensive understanding. The application of mixed-method research offers several benefits, including enhancing research possibilities, suitability for complex situations, enrichment and data triangulation. Shah and Al-Bargi (2013) elaborate on these advantages, highlighting enhanced confidence in research data, novel ways of understanding phenomena, uncovering unique findings, challenging or integrating theories, and offering a clearer understanding of the problem. However, there are also challenges associated with a mixed-methods research approach, including increased workload and resources needed, additional and diverse skills, managing two study populations, and resolving disagreements in data (Kumar, 2014). Qualitative research is primarily descriptive, aiming to explore unknown territories within natural or real-life contexts. On the other hand, quantitative research is a targeted approach with predetermined methods to test or predict theories.

As mentioned above, qualitative and quantitative research approaches are present in mixed-method research design, and a summary of these two approaches is presented (section 4.3.1.1 and 4.3.1.2), where the applicability to this study is discussed in detail (section 4.3.5).

There are different types of mixed-method approaches – three of the most common are expanded on here. Convergent mixed methods involve a simultaneous collection of qualitative and quantitative data to enhance comprehension of a specific topic (Creswell & Clark, 2011). Among mixed-method approaches, the convergent design stands out as the most renowned, with data triangulation being a key component. Cresswell and Clark (2011) characterize the convergent design as a method wherein researchers gather and analyse quantitative and qualitative data concurrently during the research phase, subsequently integrating the findings from both datasets to formulate a comprehensive interpretation. The main goal of a convergent design is to gather different yet complementary data on the same topic.

Explanatory Sequential mixed methods are typically deployed when it is necessary to explain quantitative findings, hence emphasizing a robust reliance on quantitative data as the primary data-collection approach. The outcomes of the quantitative analysis serve as guiding signs for the subsequent phase, which involves qualitative data collection. The fundamental objective of the explanatory design is to utilize quantitative data to explain the initial quantitative findings (Creswell & Clark, 2011). Leedy and Ormrod (2015) explain that the explanatory design typically unfolds in two phases. Initially, the quantitative phase entails collecting a substantial amount of numerical data; however, this phase solely yields numerical values. Subsequently, qualitative data are gathered in the next phase, using the findings from phase one to provide a deeper contextual understanding and meaning to the quantitative data collected earlier.

Typically, exploratory research is conducted in situations with limited information about a specific area (Kumar, 2014). An exploratory, sequential mixed-method design is employed when a researcher first needs to explore a topic using qualitative data before attempting to measure or test it quantitatively (Maree, 2019). Creswell and Guetterman (2019) support this concept by asserting that exploratory sequential mixed methods are employed when the instruments, variables and measures for the studied population may not be known or readily accessible. Creswell and Guetterman (2019) and Leedy and Ormrod (2021) elaborate on how the exploratory sequential mixed method lies at the core of mixed-method designs, highlighting that a project involving two or more phases has the potential to offer a more significant and enlightening contribution to the field compared to what a shorter, more limited investigation could achieve The sequential mixed method can be seen as a pragmatic paradigm-derived approach. It involves employing a questionnaire or survey as the initial data-collection method to gain insights into a specific phenomenon. Subsequently, after analysing the survey data, focus-group discussions are conducted among students to examine specific findings and encourage sharing personal experiences (Leavy, 2017).

4.3.2 Case-Study Design

A case study involves an in-depth examination of a specific situation over an extended period. The researcher would spend a specific amount of time with or in the situation to study it as it may contribute to a better understanding or inform practices of similar cases. Case studies are precious when there is limited understanding of a situation or when investigating the effects of interventions over a specific duration (Leedy & Ormrod, 2021). Kumar (2014) emphasizes that case studies are beneficial for obtaining a holistic understanding of a phenomenon or situation. The primary objective is to achieve a comprehensive understanding through interviews and observations, with data analysed thematically and synthesized to provide an overall picture of the situation(s) (Leedy & Ormrod, 2021). A case-study design assumes that the studied case is representative of similar cases, offering insights into prevalent events and situations within the group it represents. Purposive sampling is often deemed appropriate in case-study approaches, ensuring the selected sample furnishes comprehensive information for a holistic understanding of the case (Kumar, 2014). Lambert (2019) further emphasizes that the case study serves as a research design tailored explicitly for cultivating, expanding and enriching understanding and knowledge of real-world aspects, thereby making significant contributions to social research.

The next section of this chapter presents an overview of the target population and sampling methods, together with the practical implementation of this study (section 4.4.3).

4.4 TARGET POPULATION AND SAMPLING METHODS

When conducting research, consideration must be given to the most suitable target population and the most appropriate type of sampling method. Not only is the sampling method and target population crucial to reaching the study's objectives, but it also affects the validity and reliability of the results. Cresswell and Guetterman (2019) define a population as individuals sharing a distinguishing characteristic that sets them apart from other groups. Furthermore, they define a target population or sampling frame as the specific list of sampling units from which the sample is chosen. Additionally, they elaborate that a sample represents the subset of participants in a study selected from the target population to which the researcher extends generalisations. Naoum (2007) describes a sample as a representative portion selected from an entire population to demonstrate what the rest is like.

Sampling typically falls into two categories: probability sampling methods and non-probability sampling methods. Probability sampling is a random sample selection from a target population; non-probability sampling is non-random and more intentional (Leedy & Ormrod, 2021). In qualitative research, the sample choice is purposeful and determined by the researcher's decision to identify individuals likely to offer comprehensive and varied information (Kumar, 2014). Furthermore, the selection of the sampling method is determined by the research purpose and intention. When selecting participants for the study, it is crucial to ensure that respondents are motivated to share the necessary information, they must also have a clear understanding of the questions, and they must have the required information (Kumar, 2014).

The probability (section 4.4.1) and non-probability (section 4.4.2) sample selection methods and the applicable target population and sampling (section 4.4.3.1–4.4.3.4) for this study are discussed.

4.4.1 Probability Sampling/Random Sampling

Probability sampling is a random sample selection of the target population. There are various options for random sample selection, such as simple random sampling, stratified random sampling, proportional stratified sampling, cluster sampling, and systematic sampling (Leedy & Ormrod, 2015; Maree, 2019). Random sampling ensures that each member of the target population has an equal opportunity to be included in the study sample. This methodology is a crucial requirement for experimental and survey research, as it attempts to derive conclusions about the broader population based on the survey results (Bertram & Christiansen, 2015).

4.4.2 Non-probability Sampling/Non-random sampling (purposive)

Non-probability sampling selections are intentional and non-random and include convenience, quota, purposive, judgemental, expert, accidental and snowball (Leedy & Ormrod, 2015; Kumar, 2014; Maree, 2019). Purposive sampling involves deliberate decisions by the researcher regarding the inclusion of specific individuals, groups or objects in the sample. This approach is deemed suitable when the researcher has no intention of generalizing the results beyond the selected group (Bertram & Christiansen, 2015). Leavy (2017) describes that purposive sampling operates under the assumption that selecting the most suitable cases for the study yields the best data, thus seeking information-rich participants.

4.4.3 Selection of Target Population and Sampling for the Current Study

The applicable target population for the study and the first methodology is the 2023 first-year student cohort registered in the building measurement module at South African universities offering quantity surveying courses. As seen in Chapter 1 and Appendix 3, multiple higher education institutions offer accredited quantity surveying programmes in South Africa; only these institutions offering accredited courses in quantity surveying were included in the target population and sampling frame. From the identified institutions, only four institutions offer the building measurement module on the first-year level from the first semester, and one institution offers the building measurement module in the second semester of the first year of study, as depicted in Table 4.1.

The sampling method used for this study’s first and second methodology is a non-probability purposive sampling method. Participants (students and lecturers) were intentionally selected because of their specific position, experience and situation. They consisted of first-year students registered in the building measurement module and lecturers presenting this module at universities offering accredited quantity surveying programmes in South Africa.

In Figure 4.3 below, the inclusion criteria for student participation are outlined. Notably, the target population begins with the broader category of first-year students across South African universities. It then becomes more specific, focusing on first-year students enrolled in quantity surveying programmes at these universities. Subsequently, the sample comprises first-year students studying accredited quantity surveying programmes at South African universities. Further refinement narrows the target to include first-year students enrolled for an accredited quantity surveying programme at a South African university registered in the building measurement module.

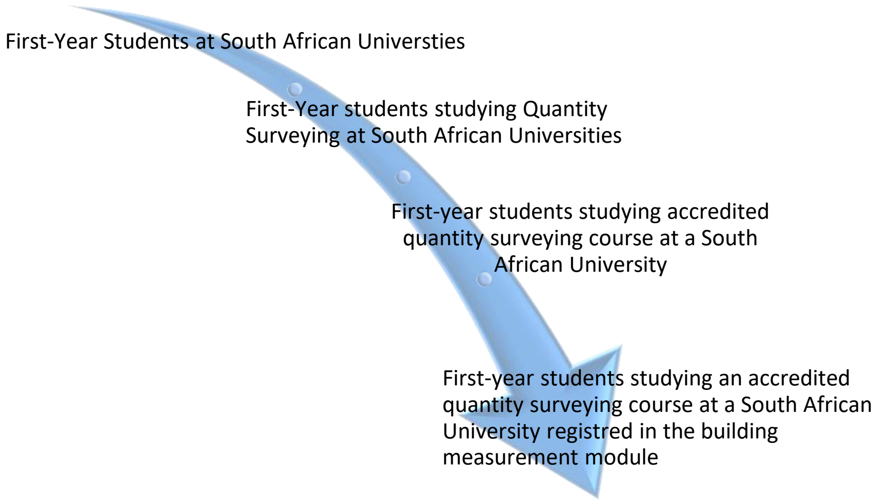


Figure 4.3: Student Target Population and Sample Selection (Source: Author's compilation)

Table 4.1: Target population and sampling: Inclusion Criteria

	Module offered in the First Semester	**Module offered in the Second Semester**	**Baseline Survey**	**Focus-Groups**	**Semi-structured interviews**	**Case Study**
Institution 1	√	√	√	√	√	
Institution 2	√	√	√	√	√	
Institution 3	√	√	√	√		√
Institution 4		√			√	
Institution 5	√	√	√	√	√	

Five institutions were identified and invited to participate in the research study. Table 4.1 illustrates the five institutions, whether they offer the building measurement module in the first or second semester, and whether they form part of the target population and sample selection.

Table 4.1 indicates that Institution 1 presented the building measurement module from the first semester to the first-year level. Therefore, students were invited to participate in the baseline survey and the focus-group discussions. The lecturer of the building measurement module at Institution 1 was also invited to participate in the semi-structured interviews. Institution 1 does not form part of the case-study sample.

Institution 2 is exactly similar to Institution 1, as depicted in Table 4.1 where students and the lecturer form part of the sample for the baseline survey, the focus-group discussions and the semi-structured interview.

Institution 3 is also similar to the first two institutions, except that this institution's first-year students registered for the building measurement module are the sample chosen for the case study. The lecturer of this cohort will not form part of the sample of the semi-structured interviews, as the lecturer and the researcher is the same person.

Institution 4 presents the building measurement module from the second semester on the first-year level. However, the students from this institution were not invited to participate in the baseline survey or the focus-group discussions, as the data collection took place in the first semester of the academic year and students were not available to participate. The lecturer of Institution 4 was invited and participated in the semi-structured interviews conducted in the first semester.

Students and lecturers from Institution 5 were invited to participate in the research study and form part of the target population and the sample.

In subsection 4.4.3.1 the practical selection of the sample is explained for the various data-collection instruments used in this study, including the first and second methodology.

4.4.3.1 ***Baseline Survey*** *– Target population and sampling*

An online baseline survey (see Appendix 11) was provided to first-year students registered in the building measurement module at four identified institutions (see Table 4.1). It was an online survey compiled using QuestBack software. A quick response (QR) code was also created for the questionnaire, and together with the link to the survey, it was made available to the students to participate voluntarily. The link to the survey and the QR code were emailed to the module lecturers, and they distributed it on their Learning Management Systems (LMS) for the students to access. A purposive sampling technique was used to distribute the survey among first-year students at identified universities offering the building measurement module on the first year and from the first semester. The composition of the survey is presented in detail (section 4.5), and the data analysis procedure of the survey is presented (section 4.6) in this chapter.

4.4.3.2 ***Focus-Group Discussions*** *– Target population and sampling*

Also forming part of the first methodology, focus-group discussions with first-year students were undertaken. First-year students from four institutions were invited to participate (see Table 4.1). Insitution four only offered the building measurement module in the second semester on the first-year level and was not invited to participate in the focus-group discussions (see Appendix 12). Purposive sampling was also used for the focus-group discussions. The invite to volunteer to participate in the focus-group discussions was sent to the module lecturers, and the students could give their names to the lecturer if they wanted to participate.

4.4.3.3 ***Semi-Structured Interviews*** *– Target population and sampling*

The lecturers presenting the building measurement module on the first-year level form part of this study's target population and purposive sample. Among the five universities offering the module, only four are included in the final interview sample selection. This exclusion results from the researcher being a lecturer at one of the universities, rendering her unable to participate in the interviews. Lecturers were emailed and asked to participate in the research through the semi-structured interviews (see Appendix 13).

4.4.3.4 ***Case Study*** *– Target population and sampling*

The first methodology informed the second methodology and comprised a case-study application where a first-year student cohort was identified to participate in the research. For the case study, a non-probability purposive sampling technique is applied. It includes the 2023 first-year student cohort in the building measurement module at one institution offering an accredited quantity surveying programme. In addition to the sample being purposive, the sample is also based on convenience selection. As I am also the lecturer of this module, applying the case study was purposive and convenient. Ethical considerations are presented in detail in section 4.9.

After the target population and sample selection have been presented in the preceding sections, the various data-collection instruments deployed in the first and second methodology will be presented in the next section.

4.5 DATA-COLLECTION METHODS

Data-collection methods refer to a specific process to gather information or data using various instruments such as surveys, interviews, observations, etc. The research questions and objectives of the study will guide the choice of data-collection method. It is important to choose to most suitable type of data-collection method(s) as it will influence the validity and quality of the data.

In the subsections below, various data-collection methods are presented as an overview, and in the last subsection of 4.5.7, the data-collection approach to the current study is presented; in other words, the data-collection instruments used in this study are presented and discussed.

4.5.1 Questionnaires

Questionnaires are commonly employed to determine individuals' attitudes, beliefs, opinions and accounts of personal experiences and behaviours (Leavy, 2017). According to Creswell and Guetterman (2019), a questionnaire is defined as a survey where participants in the study complete and return it to the researcher, choosing answers to the questions and providing basic personal or demographic information. Collecting data through questionnaires is cost effective and offers greater anonymity. However, limitations exist, as questionnaires may provide limited data, necessitating options for clarification or supplementation of answers. Questions must be clear, understandable and in a logical sequence. With the technological advancements and possibilities, online questionnaires are also popular nowadays (Kumar, 2014). Bertram and Christiansen (2015) explain that utilizing a questionnaire offers several benefits, such as its suitability for administration to a sizable group of individuals. Information can easily be captured electronically, and responses are easily quantifiable. Questionnaires standardize questions, ensuring consistency and limiting the scope of information respondents provide. Accessibility through email or the internet facilitates reaching a broad, geographically distributed audience within a limited timeframe.

In contrast to the benefits, using a questionnaire comes with certain limitations. The absence of the researcher to clarify the questions can pose challenges, and respondents may face difficulty understanding certain questions. Additionally, questionnaire participation demands the respondents' literacy skills (Bertram & Christiansen, 2015).

4.5.2 Semi-structured Interviews

Semi-structured interviews, less formal than their structured counterparts, are centred around critical topics with a combination of open and close-ended questions. As noted by Naoum (2007), these interviews involve indirect questioning, allowing interviewers flexibility to probe specific areas of the discussion. According to Leedy and Ormrod (2021), interviews serve as effective data-collection tools, accommodating various questions about facts, people's beliefs, feelings, motives and behaviours. Interviews are valuable as they can offer in-depth information, questions can be explained, and the information the respondent provides can be supplemented. Interviews are instrumental in complex situations; however, caution must be exercised to avoid researcher bias, and data quality depends on the interaction between the respondent and the researcher (Kumar, 2014). The use of interviews comes with both advantages and disadvantages. Among the positive aspects, the researcher's presence during the interview ensures clarity in understanding questions by the respondent. This interactive setting allows for additional queries, enabling more detailed data collection and clarification on specific points. Interviews can be more conducive to respondents expressing themselves verbally, particularly when compared to the task of writing lengthy responses. This method is particularly effective in gathering rich, descriptive data, especially when aiming to obtain in-depth insights from a limited number of respondents, which may be challenging with questionnaires. Several drawbacks come with using interviews, as an interview serves not only as a data-collection exercise, but also as a social and interpersonal encounter. Interview participants must be mindful of power dynamics that can potentially influence the overall process. Moreover, interviews generate substantial amounts of textual data, and the reliance on self-reporting may introduce challenges related to data verification (Bertram & Christiansen, 2015). Lambert (2019) remarks that in social research, extensive collection of qualitative data is necessary to gain a deeper understanding of the experiences and perceptions of those involved, making for a less formal approach and using the semi-structured interview.

4.5.3 Focus-Group Discussions

In focus-group discussions, the aim is to explore the perceptions, experiences, and understandings of individuals who share common experiences related to a particular situation (Kumar, 2014). Broad discussion topics are presented during the focus-group discussions, allowing group members to express their opinions and experiences while the researcher records this information. According to Creswell and Guetterman (2019), a focus group entails participant interaction, extensive data collection, and active participation from all group members. The researcher will introduce the topic of discussion, ensure balanced participation, and keep the group focused on the discussion. Focus groups are highly effective when participants feel at ease sharing their thoughts and feelings, and group interactions yield more information than individual interviews. Data collected through focus-group interviews can be beneficial and can cover various issues and diverse opinions; however, if the researcher wants more depth of the issue(s) or topic, it might not emerge through focus-group discussions, but rather through individual interviews. (Leedy & Ormrod, 2015; Kumar, 2014). Conducting open-ended focus-group discussions allows students to discuss issues they think are important, utilizing their own language and recounting experiences in detail through stories and examples. With minimal moderation, the discussion can be guided by posing critical questions, granting students the freedom to express themselves at their discretion. The primary advantage of this approach lies in the ability to gather in-depth data enriched with descriptions and examples, fostering a more authentic exploration of the topics under discussion (Leavy, 2017).

4.5.4 Observations

Observation is a widely favoured data-collection method, particularly in qualitative research, and is prominently utilized within case-study designs. The primary objective of employing observations is to explore deeply into a particular situation or group, developing a comprehensive understanding. Within qualitative frameworks, observations are intentionally unstructured, allowing for a free-flowing and flexible exploration, which presents a significant advantage to the researcher. These observations are meticulously recorded, capturing intricate details. From this rich dataset, the researcher can construct a complex, yet integrated picture of interaction among students (Leedy & Ormrod, 2015). Kumar (2014) elucidates that gathering data through observations involves a deliberate and systematic approach to observing and listening to interactions as they unfold. Lambert (2019:23) describes observation as an opportunity to “gain a closer understanding of what happens in real life”.

4.5.5 Reflection

Reflection as a data-collection method entails individuals pondering their thoughts, emotions and experiences. This practice is widely embraced in qualitative research, allowing participants to introspect and articulate their perspectives, opinions and experiences throughout the research journey (Ortlipp, 2008). Even beyond formal reflection studies, this process can yield valuable data insights. Deggs and Hernandez (2018) explain that reflection, or reflective research, is inherently retrospective, centring on the impacts of the research endeavour. Reflective data can originate from either the researcher or the participants involved in the study. Nonetheless, the researcher must step back and critically evaluate the process while remaining mindful of their positionality.

4.5.6 Pre- and Post-Tests

Pre- and post-test designs are commonly utilized within quantitative research designs. Essentially, they serve as assessment measures administered to participants before and after engaging in a specific intervention. Participants undergo the pre-test assessment before the intervention, followed by a post-test assessment upon completion, allowing researchers to gauge the intervention’s impact. The primary aim of pre- and post-tests is to identify the participants’ learning needs and assess the extent of knowledge acquisition following the intervention.

4.5.7 Data-Collection Methods and Instrument Design

The data collection methods and instruments employed in this study were meticulously developed, drawing upon existing literature, current trends in learning and teaching, as well as the researchers' own experiences in this field.

4.5.8 Data-Collection Methods Used in this Study

In the convergent mixed-method approach, the first methodology, quantitative and qualitative data were collected from the baseline survey. The focus-group discussion with first-year students yielded primarily qualitative data similar to the semi-structured interviews with the lecturers. Data obtained in the second methodology, the case study – qualitative data – were predominantly collected.

4.5.7.1 Baseline Survey Data Collected (Appendix 11)

The **baseline survey** was the first data-collection instrument used in this study. The primary purpose of the online baseline survey was to determine basic, but essential information about first-year students and their preparedness when they enter higher education. Basic demographical questions such as age and gender were included, and the questions on students' academic experiences, industry knowledge, and perceptions, as well as prior knowledge and current level of knowledge about crucial building measurement module elements, were included in the survey. A total of 31 questions were included in the survey, with multiple open-ended and closed-ended questions. Likert scale was applied to some of the close-ended questions. On the first page of the survey, participants gave informed consent to participate.

As seen in Table 4.2 from Institution 1, 61 students participated in the survey; from Institution 2, 20 students participated; and 24 from the third Institution responded.

The various lecturers of the building measurement module on first-year level assisted with distributing the link and QR code of the survey among their students via various platforms, mainly the learning management system (LMS), as the Protection of Personal Information Act (POPIA) restricts the sharing of third-party personal information. Thus, I had no access to the student participants' contact details. Lecturers were encouraged weekly to remind students to complete the survey. Table 4.2 below displays the participation and response rates for the three institutions participating in the baseline survey.

Table 4.2: Participation Data – Baseline Survey

	Total number of students registered for the building	**Total population of QS students**	**Total number of students who**	**Response Rate**

	measurement module		participated in the survey	
Institution#1	137	74	61	82%
Institution #2	76	45	20	44%
Institution #3	26	26	24	92%

The second column of Table 4.2 presents the total number of students enrolled in the building measurement module. However, it is worth noting that at Institutions 1 and 2, students from other disciplines, such as construction management and property studies, are also included in this module. The second column further specifies the total number of quantity surveying students registered in the building measurement module, as they constituted the specific target group for this study. The last column indicates the response rates for the baseline survey. Institutions 1 and 2 had high response rates, the response rate of Institution 2 is lower, but still satisfying. As mentioned earlier in this section, students from institution four were not available to participate in the survey as this module is presented in the second semester. An invitation to students from Institution five to participate in the survey was extended, but unfortunately, no responses were received from this institution.

4.5.7.2 Focus-Group Discussions Data Collected (Appendix 12)

Three institutions took part in the focus-group discussions. From Institution 1, 31 students volunteered to participate in the focus-group discussions. The students were divided into three groups. From the second institution, 15 students participated in the focus-group discussions, and nine from the third institution volunteered. The discussions were recorded and transcribed. Data were thematically grouped and analysed, as seen in Table 4.3.

Table 4.3: Participation Data – Focus Groups

	Total number of students registered for the building measurement module	Total population of QS students registered in the	Total number of students who participated in the

		building measurement module	focus-group discussions
Institution#1	137	74	31
Institution #2	76	45	15
Institution #3	26	26	9

As per Table 4.3, Institution 1 had 31 students who volunteered to participate in the focus-group discussions. The students were divided into three groups, with 10, 10 and 11 students, respectively. Fifteen students from Institution 2 volunteered to participate in two groups of 9 and 6 students, respectively. Nine students from Institution 3 participated and constituted one group of nine students. The data analysis of the discussions is presented in section 4.6 of this chapter.

4.5.7.3 Semi-structured Interviews Data Collected (Appendix 13)

Four first-year lecturers presenting the first-year building measurement module were invited to participate in the semi-structured interviews. Interviews with lecturers at Institutions 1 and 2 took place in a face-to-face setting, and lecturers from Institutions 4 and 5 engaged in online interviews. The interviews took between 40 and 60 minutes each. The discussions were recorded and transcribed, and the data were thematically grouped and analysed.

4.5.7.4 Case-Study Data Collected

The data collected through the second methodology, the case study, are presented in detail in the Chapter 6. These data were gathered via pre- and post-tests and participant observations and self-reflection from the researcher and the participants.

4.6 DATA ANALYSIS

The process of data analysis involves the conversion of raw data into meaningful insights and conclusions relevant to the research problem. This involves thoroughly examining and interpreting the data to uncover trends, patterns or relationships. Leavy (2017) describes the process of data analysis and interpretation as finding the answers to the posed research questions. According to Leedy and Ormrod (2015), the research process consists of three interconnected steps: data collection, analysis, and interpretation.

According to Bertram and Christiansen (2015), there are two approaches in qualitative data analysis: the deductive approach and the inductive approach. Both approaches can be included in the data-analysis process. Bertram and Christiansen (2015) further outline three key activities within the data-analysis process, starting with data reduction, followed by data display, and culminating in data verification and conclusions derivation.

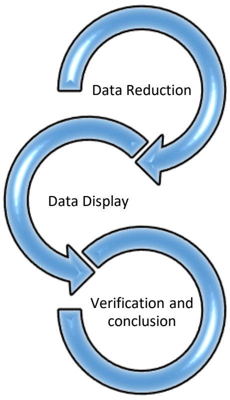


Figure 4.4: Data-analysis process (Adapted from Leedy & Ormrod, 2015)

4.6.1 Data Analysis of Surveys

The analysis of survey data typically commences with descriptive statistics, which involve summarizing nominal and ordinal data in terms of frequencies and percentages. These statistical measures are integral to quantitative analysis and valuable in mixed-method research endeavours (Lambert, 2019). The survey data were analysed using the QuestBack software, with each survey question's data presented individually. Analysis was conducted separately for each institution, followed by comparison and presentation of results in the respective sections. The survey data comprised both quantitative and qualitative data.

4.6.2 Data Analysis of Semi-Structured Interviews and Focus-Group Discussions

Data gathered from interviews undergo recording and transcription. As the researcher listens to the recordings and reviews the transcripts and notes, they should be capable of discerning patterns within the responses offered by the interviewees (Lambert, 2019). The semi-structured interviews with the lecturers were recorded, transcribed and subsequently thematically grouped. Analysis of this qualitative data was conducted individually for each participant, followed by integration, comparison and presentation of findings. The data analysis for the focus-group discussions followed a similar approach to that of the semi-structured interviews. Discussions were recorded, transcribed, and then thematically grouped. The data were subsequently compared and presented, mirroring the process used for the interviews.

4.6.3 Data Analysis of Case Study

In data analysis of observations, researchers identify and code themes present in the activities and interactions observed. These findings serve to establish meaning, perspectives, and understandings gained from the observed phenomena. The data collected in the case study and its subsequent analysis primarily involved a detailed examination of the pre- and post-test data from the students, conducted quantitatively. Additionally, qualitative analysis was performed on the data gathered from lecturer observations and student reflections.

4.7 QUALITY IN MIXED-METHOD RESEARCH

To determine and ensure the quality of this research, triangulation, credibility, dependability, confirmability and transferability of the study are evaluated.

4.7.1 Triangulation

Triangulation, as defined by Creswell and Guetterman (2019), involves collecting and integrating different data sets concerning the same phenomenon, leading to enhanced research quality. As described by Maree (2019), triangulation is a process of validating findings; Leedy and Ormrod (2015) affirm that data triangulation is commonly used to support the credibility and validity of the research outcomes. Bertram and Christiansen (2015) define triangulation as gathering data from multiple sources. Kumar (2014) explains that triangulation entails using the same data set from multiple sources, collecting through different approaches, and then drawing conclusions and examining the problem, situation, or phenomenon from different perspectives. Triangulation is particularly prevalent in qualitative research, where multiple data sources are gathered with the premise that they will converge to support a specific hypothesis or theory (Leedy & Ormrod, 2015).

4.7.2 Credibility (Internal validity in quantitative research)

Credibility relates to the researcher's ability to investigate a problem in alignment with the reality constructed by the researcher. In addition, the credibility of both the data and its analysis should be believable, trustworthy and authentic. While credibility corresponds to internal validity in the positivist paradigm, within the interpretive paradigm, it is a distinct concept (Kivunja & Kuyini, 2017). Maree (2019) emphasizes that validation depends on the open and transparent nature of the research processes, creating a clear 'audit trail' of decisions and interpretations throughout the research process. This transparency enables the reader to assess if the process aligns with the requirements of valid research. To ensure the credibility of the research, Maree (2019) suggests adopting well-established research methods, designing the research to fit the research question, and aligning the theoretical underpinning with the research questions and methods.

4.7.3 Dependability (Reliability in quantitative research)

In the positivist paradigm, dependability is synonymous with reliability, while in the interpretivist paradigm, it is termed 'dependability'. Dependability, within an interpretivist framework, is dependent upon the researcher's ability to construct meaning (Kivunja & Kuyini, 2017). Kumar (2014) points out the importance of maintaining an extensive and detailed record of the research process for others to replicate, thereby assessing the level of dependability. As Maree (2019) highlights, dependability is demonstrated through the research design and its execution, the operational specifics of data collection, and the reflective evaluation of the project. Additionally, Maree (2019) emphasizes that documenting the analysis process is crucial, allowing others to understand the decisions, analytical approach, and path taken to arrive at interpretations.

4.7.4. Confirmability (Objectivity in quantitative research)

Confirmability can be referred to as the level of impartiality or neutrality or the extent to which the study's findings are influenced by participants instead of the researcher being biased (Maree, 2019).

4.7.5 Transferability (external validity in quantitative research)

Termed external validity within the positivist paradigm involves enabling readers to relate the findings to their contexts (Kivunja & Kuyini, 2017). Though establishing transferability is challenging due to the research approach adopted, Kumar (2014) suggests that comprehensive and thorough descriptions of the process can, to some extent, facilitate replication by others. Maree (2019) defines transferability as inviting readers to draw connections between elements of a study and their own experiences or research, emphasizing the potential to apply the findings to their specific environment or circumstances. Maree (2019) stresses the importance of providing readers with detailed descriptions of research participants, research design, and the study's context to enhance transferability in qualitative research. Based on these details, readers can make informed decisions about the transferability of the research to their community or practice. Leavy (2017) describes transferability as the transfer of the research findings to other contexts and to be valuable beyond one's data.

4.7.6 Reflexivity

Reflexivity is an introspective process that involves acknowledging and minimising biases to enhance their research ultimately. In this process of reflexivity, researchers make an effort to recognize their personal, social, and political or philosophical biases towards the research study that could have an impact on their data collection and interpretation (Leedy & Ormrod, 2021). Creswell and Guetterman (2019) confirm that when the researcher reflects on their participation in the research study, it is important to think critically about personal biases, values and assumptions. Leavy (2017) explains that reflexivity entails being aware of how power has an impact on the researcher's attitudes and behaviours while acknowledging the contribution and influence on the research experience.

4.7.7 Quality Measures Implemented in this Study

The triangulation of data in this research serves as a vital cornerstone for ensuring quality, as it involves the collection of data through various methodologies. By employing a convergent mixed-method approach, data are gathered from multiple angles, providing a comprehensive understanding of the issue at hand. These diverse sources include surveys, and focus-group and semi-structured interviews. Triangulation stands as a crucial marker of the study's quality, affirming the reliability and validity of the findings.

Within this context, transferability refers to the framework's adaptability by lecturers at different higher education institutions teaching the building measurement module at NQF level 5 to suit their specific contexts.

The study's credibility serves as a critical benchmark for its quality. Transparency in data collection and analysis is paramount, with a readily accessible audit trail provided for all gathered data and subsequent analyses; this ensures accountability and reinforces the reliability of the study's findings.

4.8 LIMITATIONS, DELIMITATIONS AND ASSUMPTIONS

4.8.1 Limitations

The dynamics between the lecturer and researcher, particularly in case-study design, may present a constraint in this study. Nevertheless, the researcher's positionality has been thoughtfully taken into account and is presented in section 4.10.

4.8.2 Delimitations

This study only focuses on first-year quantity surveying students in a full-time, SACQSP-accredited qualification at a traditional university in South Africa.

4.8.3 Assumptions

It is assumed that students entering the building measurement module at the first-year level have limited prior knowledge and experience regarding the built environment and related activities and are underprepared in general for higher education. It is also assumed that constructivism, specifically scaffolding teaching interventions, can enhance and successfully support the first year's learning and teaching in the building measurement module. It is assumed that lecturers in the building measurement module on the first-year level experience teaching challenges and difficulties. Furthermore, it is assumed that the majority of the students on the first-year level experience learning difficulties and challenges in the building measurement module.

4.9 ETHICAL CONSIDERATIONS

It is essential to maintain ethical practices throughout the research process. Ethics are a complex matter that extends beyond institutional guidelines or rules, and they should be a firm basis for the researcher's approach to the study. Ethical issues in data collection and data reporting should be well understood by the researcher (Creswell & Guetterman, 2019). Furthermore, it is important to consider ethical issues relating to the researcher, such as avoiding bias, provision or deprivation of treatment, using inappropriate research methodology, incorrect reporting, and inappropriate use of information (Kumar, 2014). The researcher needs to consider all possible factors that could cause possible harm to the participants in the execution of the research, especially when working with human participants. All participants should be treated with respect and consideration (Leedy & Ormrod, 2015).

According to Leedy and Ormrod (2021), ethical guidelines in mixed-method research are essential and include voluntary and informed consent, protection from harm, and the participant's right to privacy and honesty. Kumar (2014) underscores the importance of managing ethical issues arising from activities such as collecting information, obtaining consent, offering incentives, handling sensitive data, potentially causing harm to participants, and maintaining confidentiality. Bertram and Christiansen (2015) outline three crucial ethical principles in research: autonomy, non-maleficence and beneficence. Respecting the autonomy of all study participants is essential, ensuring voluntary involvement with the freedom to withdraw at any time. Researchers must communicate expectations to enable participants to make informed and voluntary choices. Informed consent is essential, requiring of participants to agree to engage in the study. Non-maleficence, or the principle of 'not harm', encompasses preventing emotional, physical and social harm to participants. Confidentiality is integral to this principle, assuring participants of the study's confidentiality. The principle of beneficence emphasizes that research should be significant and beneficial to society, highlighting the importance of positive impact and societal value.

Adhering to essential ethical guidelines is imperative for the researcher. Firstly, participants must comprehensively understand the study's purpose and willingly choose to participate. Secondly, researchers must avoid distorting the voices or perspectives of the participants, maintaining the integrity of their contributions. Anonymity is essential and requires of researchers to safeguard the identities of participants. Additionally, researchers are responsible for providing participants benefits and must carefully balance these benefits against potential risks. Upholding the principle of non-malfeasance, researchers are obligated to avoid causing harm throughout the research process. These ethical considerations are crucial in conducting research with integrity, transparency and a commitment to the participants' well-being (Karnieli-Miller, Strier & Pessach, 2019).

The right to privacy is another critical aspect of ethics and should be strictly applied by the researchers. Under no circumstances has the researcher the right to discuss any of the data without the participants' consent (Leedy & Ormrod, 2015).

In the new day and age, where technology is assisting greatly in the collection and analysis of data, it is also essential to consider the implications of data storage on the cloud, for instance. Accessibility to these data should be strictly limited and it is recommended to be encrypted, as these data should be stored for at least five years. Security issues such as data confidentiality, data integrity, data sovereignty and data privacy are essential to consider. The risk must be mitigated in these issues. As per Maree (2019), data confidentiality and integrity are the developer's responsibility, while data sovereignty and privacy are the researcher's responsibility. The researcher should be conscious about strong passwords, regular backups and data safekeeping.

Bias is also an important consideration, and it refers to a deliberate effort to either obscure or emphasize findings discovered in research or to purposefully employ a method or procedure that may not be appropriate, but provides the desired information due to vested interests (Kumar, 2014). Bias indicates a predisposition towards or against something or someone, limiting the ability to make impartial judgments (Bertram & Christiansen, 2014). See Appendix 6-10 for ethical approval letters from participating institutions.

As the researcher, I rigorously adhered to ethical standards, following the guidelines outlined in the ethical clearance application. Participants received the utmost respect, ensuring anonymity and voluntary participation was paramount throughout the research. Given my position as a lecturer within the student cohort participating in the case study, particular care was taken to avoid any sense of obligation or coercion for students to participate in the research.

4.10 RESEARCHER POSITIONALITY AND POWER RELATIONSHIP

In this study, it is vital to provide a positionality statement whereby the researcher states their position, biases, perspectives and background that may influence the research process and outcomes.

I am the principal investigator in this research project on pedagogical challenges among first-year students in the building measurement module at South African universities. Drawing from my role as a lecturer with fifteen years of teaching experience, including eight years dedicated to instructing the first-year building measurement module at a higher education institution offering accredited quantity surveying programmes, along with a background as a professional quantity surveyor with a decade of industry experience, I contribute a diverse array of experiences, perspectives and values that inform my approach to this study. I am aware of the potential impact of my own biases on the research process and the outcomes. I acknowledge that my positionality can affect how I formulate research questions, interpret data and interact with students and lecturers participating in this study. I am committed to maintaining transparency and reflexivity throughout the entire research process. I actively engaged in self-reflection to mitigate potential biases, sought feedback from colleagues and research supervisors, and employed rigorous research methodologies. I recognize the significance of bracketing my preconceptions to allow for a more objective exploration of the research topic. This statement serves as a transparent declaration of my standpoint, emphasizing my awareness of potential influences on the research process. It was my aim to conduct this study ethically, rigorously, and with sensitivity to the complexities inherent in the research topic.

4.11 CHAPTER SUMMARY

This chapter has provided a comprehensive overview of critical components essential to the research process. Research was defined and explored various paradigms that shape the approach to inquiry. Additionally, the significance of research design, emphasizing its role in guiding the study's methodology and understanding the target population and sampling techniques, is crucial for ensuring the representativeness and generalizability of findings. Moreover, the importance of selecting appropriate data-collection instruments tailored to the research objectives was discussed. The chapter also highlighted the significance of accurate data-analysis techniques in deriving meaningful insights from the gathered information. Furthermore, the importance of quality in research was presented, emphasizing the need for rigor and precision throughout the study. Ethical considerations were also addressed, emphasizing the paramount importance of upholding ethical standards to safeguard the welfare and rights of participants. Finally, the concept of the positionality statement was presented, acknowledging the researcher's subjective standpoint and its potential influence on the study's outcomes.

CHAPTER 5

RESULTS AND FINDINGS

METHODOLOGY 1 – CONVERGENT MIXED METHOD

5.1 INTRODUCTION

In this chapter, the results and findings of the initial methodology are presented. As discussed in Chapter 4, this study adopts a multi-method research approach due to lacking contextual knowledge. The first methodology adopts a convergent mixed-method approach, encompassing a baseline survey, focus-group discussions with first-year students, and semi-structured interviews with lecturers teaching the building measurement module at first-year level at various South African universities offering accredited quantity surveying programmes. Figure 5.1 below illustrates the first methodology, explained in detail in Chapter 4 (section 4.1).

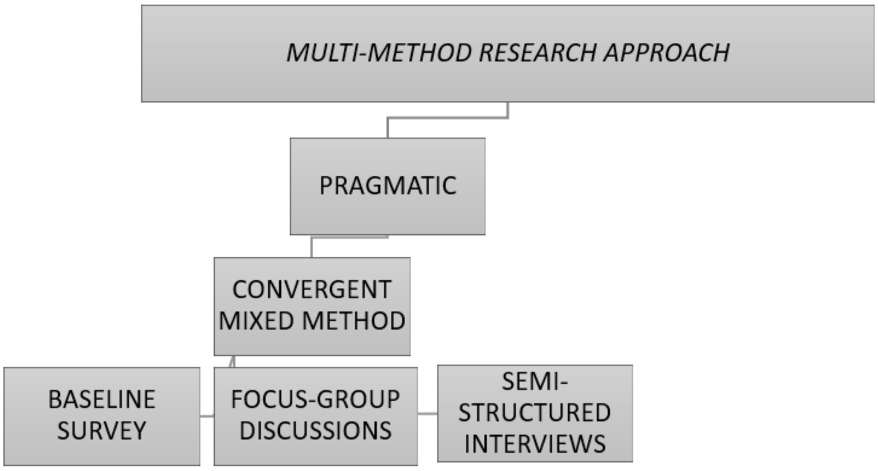


Figure 5.1: Multi-Method Research Approach: Methodology 1 – Convergent Mixed Method

A convergent, mixed-method research design was implemented to address the main research question and four sub-research questions. The main question focuses on how the learning and teaching of first-year students in the building measurement module can be enhanced through a facilitation framework. Sub-research questions include the following:

1. What is the extent of the **preparedness** level of first-year quantity surveying students in terms of prior knowledge or lack thereof to deal with the building measurement module content?

2. What is the nature of **the challenges** associated with the learning and teaching of first-year quantity surveying students in the building measurement module in South Africa?
3. What are the **current approaches** and techniques used in the learning and teaching of building measurement for first-year quantity surveying students in South Africa?
4. What is the **perceived effectiveness** of the current learning and teaching approaches and building measurement for first-year quantity surveying students in South Africa?
5. What facilitation framework towards effective learning and teaching interventions can be applied to bridge the articulation gap of first-year students so they can fully grasp and understand the context of the building measurement module?

In the first part of this chapter, the results and findings of the baseline survey are presented (see section 5.2); the second part of the chapter comprises the results of the focus-group discussions with first-year students (see section 5.3); and the results of the semi-structured interviews with the lecturers of the building measurement module are presented in the second-last section of this chapter (see section 5.4). The last section of this chapter (see section 5.5) encapsulates all the data points and themes presented, informing the second methodology.

5.2 BASELINE SURVEY RESULTS

The survey was designed to determine first-year students' baseline knowledge and preparedness upon entry into the quantity surveying programme, specifically, the building measurement module. As discussed in Chapter 4, section 4.5.7, the baseline survey had 31 questions with multiple closed- and open-ended questions. To best present and describe the quantitative and qualitative data collected from the baseline survey, the data are thematically grouped as per themes in Table 5.1 below. Five themes are identified and derived from the data collected from the survey, which are discussed in the subsequent sections of this chapter. The themes that emerged from the data were identified through a structured analysis process. The qualitative data from the survey were manually grouped into themes by identifying recurring patterns. This approach provided a systematic way of organizing and interpreting the data.

Table 5.1: Baseline Survey Data Themes

Themes		Applicable Survey Questions
Theme 1	Student Demographics	Q1, 2, 3, 4
Theme 2	Student Profile	Q5, 6, 7, 8
Theme 3	Students' perceptions of quantity surveying education and the profession	Q9, 10, 13, 14, 15, 16
Theme 4	Preparedness	Q11, 12
Theme 5	Prior knowledge and experience	Q17 - 31

As discussed in Chapter 4, five institutions were invited to participate in this research study; four institutions offer the building measurement module in the first semester as a year module and one institution offers the building measurement module in the second semester as a semester module for first-years (see Table 5.2). The fourth institution offers the building measurement in the second semester of the first year. Thus, this institution was omitted from participating in the baseline survey, as it was distributed at the beginning of the academic year. Students had not been registered yet in the building measurement module and were therefore not available to participate. The four institutions (Institutions 1, 2, 3, 5) administered the baseline survey by making it available on their LMS, where students could voluntarily access the survey via the link or the QR code provided.

Table 5.2: Participating Institutions in Baseline Survey

	Module presented in the First Semester as Year Module	Module presented in the Second Semester as semester module	Baseline Survey Participation
Institution 1	√		√
Institution 2	√		√
Institution 3	√		√
Institution 4		√	
Institution 5	√		√

Table 5.3 summarises students' participation in the survey. The total number of registered students for the building measurement module at the various institutions is indicated in column 1. In column 2, the quantity surveying student population is indicated, followed by the total number of students who participated in the survey in column 3. Columns 4 and 5 indicate the number of students who continued with the survey and the percentage response rate. It is important to note that students from other disciplines are also present in the building measurement module, as mentioned in Chapter 4.

Table 5.3: Participation Summary and Response Rate of Baseline Survey

	Total number of students registered for the building measurement module	**Total population of QS students registered for the building measurement module**	**Total number of students who opened the survey**	**Total number of students who agreed to continue with the survey**	**Response Rate**
Institution #1	137	74	61	58	82%
Institution #2	76	45	20	16	44%
Institution #3	26	26	24	24	92%
Institution #5	unknown	unknown	0	0	0%

As depicted in Table 5.3, Institution 1, 61 students accessed the survey, and 58 (95%) agreed to participate and continue with the survey. The balance of three students (5%) opted not to continue with participation in the study. At Institution 2, 20 students accessed the survey, of which 16 (80%) agreed to participate in the study. The balance of four students (20%) opted not to continue with participation. From Institution 3, 24 students accessed the survey, and all students agreed to participate in the study. The fifth institution had no responses, with no students accessing the survey or participating. Data about the total number of students in the building measurement module at the fifth institution could not be established after multiple attempts.

The following section presents the first theme: demographics, presenting relevant data obtained from the survey.

5.2.1 Theme 1: Demographics of Respondents

Theme 1 is derived from the survey data, including participants' age, year of matriculation and gender. The survey's first question was demographical and aimed to establish the average age of first-year students registered for the building measurement module. Figure 5.2 shows that students from Institution 1 (n=56) reported the following: 36% of the students were 18 years old at the time; 30% were 19; 18% of the students were 20 years old; and 7% and 5% were 21 and 22 years old, respectively. 4% of the respondents indicated 'other' as their age, indicating their age falls beyond the boundaries listed.

Data from the second institution (n=16) showed that 38% of the students were 18 years of age; 19% indicated they were 19 years of age; 13% indicated 20 years of age; and 6% indicated 21 years of age. 25% of students indicated 'other' as their age.

Students from the third institution (n=23) indicated that 30% were 18 years old; 35% were 19 years old,;9% indicated their age to be 20 years; and 4% indicated 21 years old. Another 4% indicated their age to be 22%, while 17% of students indicated 'other' as their age.

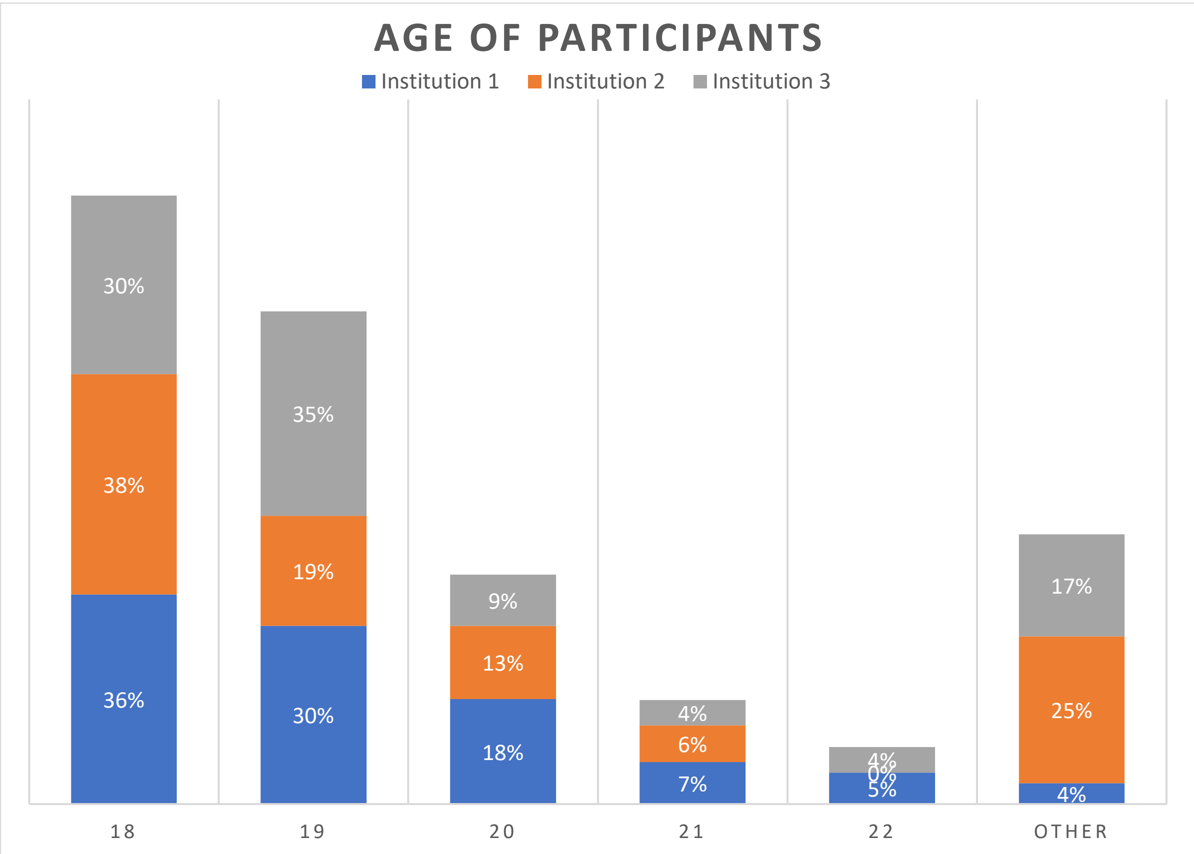


Figure 5.2: Age of Participants

It is crucial to determine the age of the first-year students as participants in this research, as it presents an understanding of their perspectives and behaviours. Most first-year students participating in this study are between the ages of 18 and 19.

In addition to determining the student's age, the year of their matriculation[1] is also an essential determinant of preparedness, prior knowledge and experience.

Figure 5.3 illustrates when participants at Institutions 1, 2 and 3 matriculated. At Institution 1 (n=58), 47% of the students matriculated in 2022, while 34% matriculated in 2021. In 2020, 12% of the students began their studies, compared to just 2% in 2019 and 3% in 2018. This pattern aligns with the age distribution of the students, as only one student reported being 24 years old. This suggests that the entire student cohort matriculated between 2018 and 2022, consistent with the age data at this institution.

At Institution 2 (n=16), almost two-thirds (63%) of the students matriculated in 2022, while 25% started in 2021. Additionally, 6% matriculated in 2017, and another 6% in 2011. Interestingly, there were no students who matriculated between 2018 and 2020.

From Institution 3 (n=24), the majority (58%) of the students matriculated in 2022; 17% indicated that they had matriculated in 2021; and 13% matriculated in 2020. Similar to the second institution, there were no matriculations in 2019 and 2018, but 4% matriculated in 2017 and 8% in 2016, respectively.

Most first-year students at Institutions 2 and 3 matriculated in 2022, while 47% matriculated in 2022 at Institution 1. Thus, Institution 1 has the highest number of 'senior' first-year students or students who did not matriculate in 2022, the year before university entry for the first time. Institution 2 had the highest number of 'fresh-out-of-school' students.

[1] Matriculation/matriculate is a colloquial reference to Grade 12, or passing Grade 12.

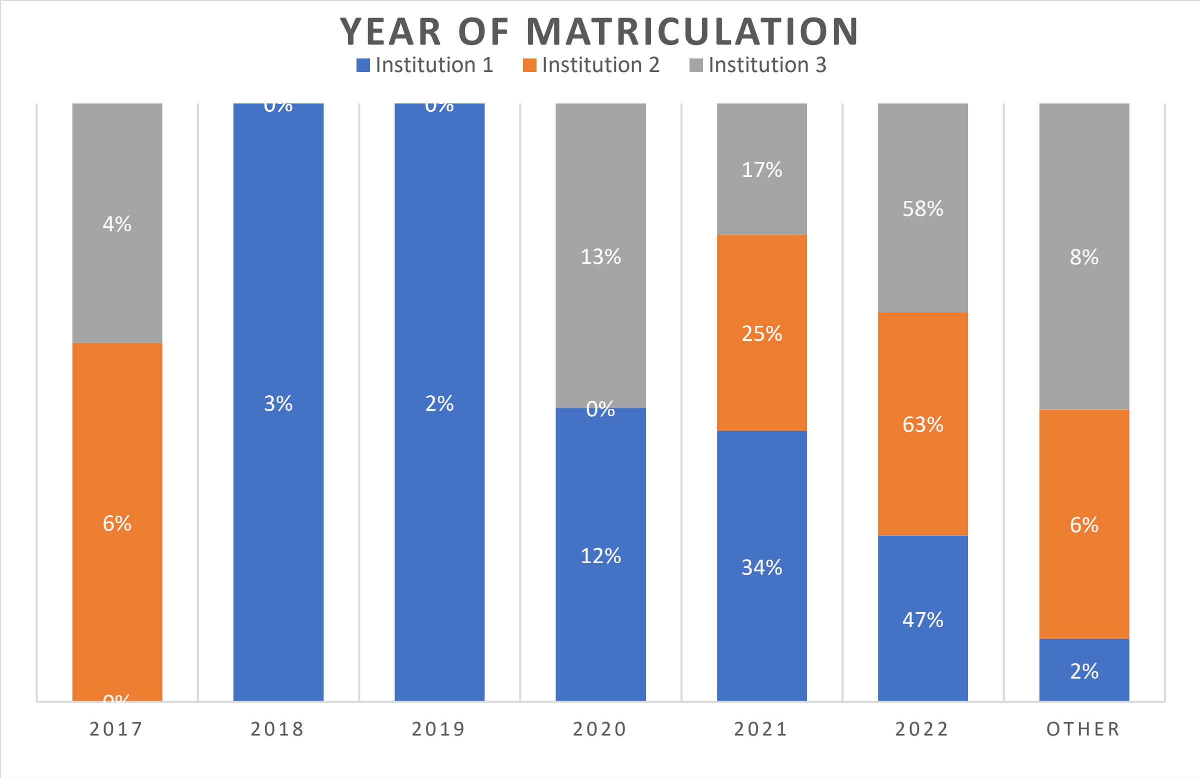


Figure 5.3: Year of Matriculation

These data, similar to data on students' age, illustrate the disparity in the age of first-year students; it is therefore for the lecturer not to assume all first-year students to be 18. This disparity could lead to challenges in terms of the teaching approaches of the lecturer, because some of the older students might have some prior knowledge or experience in the subject matter, or they might be more prepared than an 18-year-old, first-year student. Age, and thus experience by proxy, is an important determining factor of first-year university students' preparedness.

Participants were asked what they did before 2022 if they had not matriculated in 2022. Some mentioned a gap year, studying another course, being employed, upgrading matric, and enrolling for another course or programme. Thus, there is no clear pattern as to what students did if they had not matriculated in 2022.

In addition to age and year of matriculation, a question on gender was also included as part of the demographic questions. Figure 5.4 shows the gender distribution of the survey. At Institution 1, where 58 students participated in the survey, 59% identified as male, while 41% identified as female. Similarly, at Institution 2, with 16 participants, 56% were male and 44%

were female. At Institution 3, where 23 students participated, the majority (65%) identified as male, while 35% identified as female.

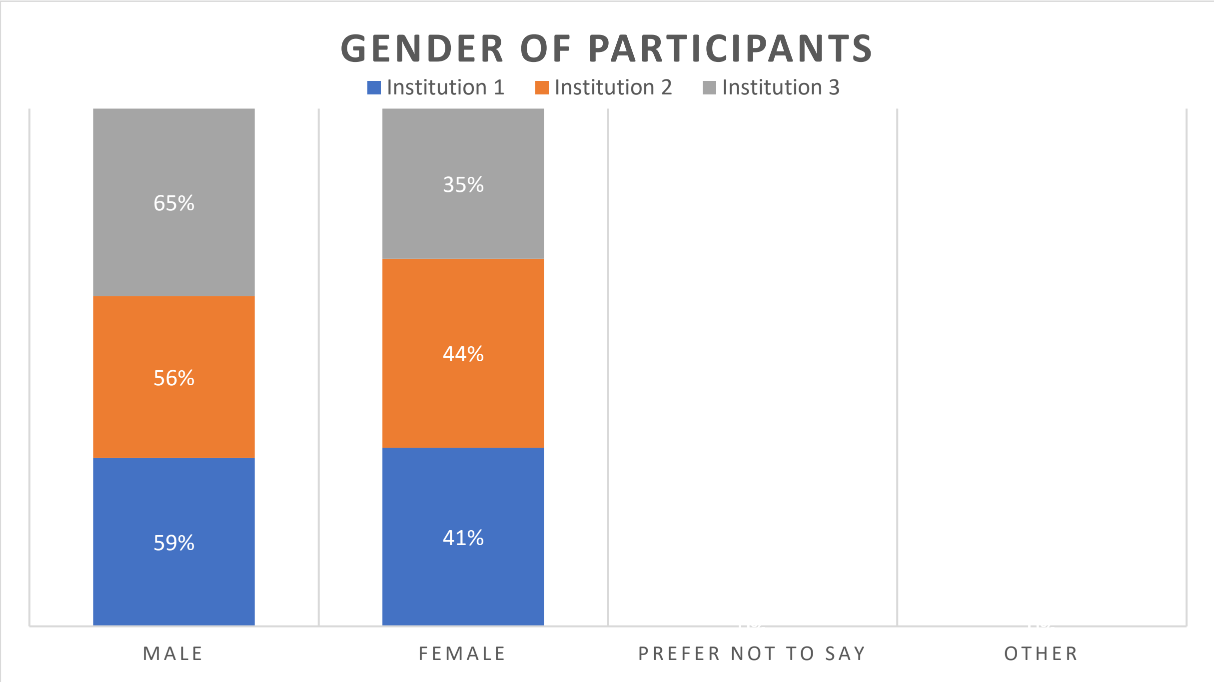


Figure 5.4: Gender of participants

From these data, the male dominance of the quantity surveying profession is reflected, with the majority of students being male at all three institutions. At Institution 3, the male dominance is the highest, with Institution 2 being relatively equally represented by males and females. This data does not have any significant influence on the main problem of this current study.

To summarize, the most prominent data presented in Theme 1 is that it is evident that most first-year students entering university, specifically the quantity surveying programme for the first time, are male and between 18 and 19 years old.

The relationship between university readiness and the age of students is complex. Typically, older students may possess more life experience and maturity, potentially enhancing their readiness for university. Age has a significant impact on the preparedness level of students and the way they might handle challenges. The survey data indicated a predominantly male presence within this sample, particularly at Institution 3. The construction industry and the field of quantity surveying continue to exhibit male dominance, both in representation and environment. This finding aligns with a study conducted by Panojan, Perera and Dilakshan in 2022.

The next section asked students about their prior qualifications and enrolment history. The purpose of including these questions in the baseline survey was to establish if the students have any prior qualifications or enrolments that may directly influence their preparedness, readiness, and prior knowledge and experience as first-year student.

5.2.2 Theme 2: Student Profile – Prior Qualification and Enrolment

Questions 5– of the survey form part of the data reporting under Theme 2, as depicted in Table 5.1. These questions aimed to determine if the students held any prior qualification, diploma, or degree other than matric.[2]

Among the surveyed students, none from the first institution (n=58) or the second institution (n=16) reported having additional qualifications. Only one student from the third institution (n=24) acknowledged having a prior qualification, excluding matriculation. In a follow-up question, students needed to specify which prior qualification/diploma/degree they hold. Still, since only one student from Institution 3 indicated a prior qualification, they stated the following:

> *I received an online diploma for completing the Young Minds course at (another Institution).*

Questions 7 and 8 of the survey inquired about the enrolment of a programme or qualification before students' current enrolment for the Quantity Surveying programme. If students had enrolled for a prior qualification, it could have influenced their preparedness and prior knowledge when entering the building measurement module hence the inclusion of this question. Distinguishing between a prior qualification and prior enrolment is crucial, as both hold equal significance. Still, prior enrolment refers to a student being registered for a different qualification before enrolling in the quantity surveying programme, whereas qualification means students completed the course or programme. However, it is important to note that prior enrolment does not necessarily imply completing that qualification; in essence, students may have been enrolled but did not fulfil the requirements to obtain the qualification.

In Figure 5.5, 28% of the students at Institution 1 (n=57) indicated they had enrolled for a prior qualification. 19% of the students at the second institution (n=16) indicated that they had

[2] Matric is a colloquial term used in South Africa to refer to the final examination at the end of high school. Officially the examination is called Grade 12.

previously enrolled for another qualification, as did 29% of the students at the third institution (n=24).

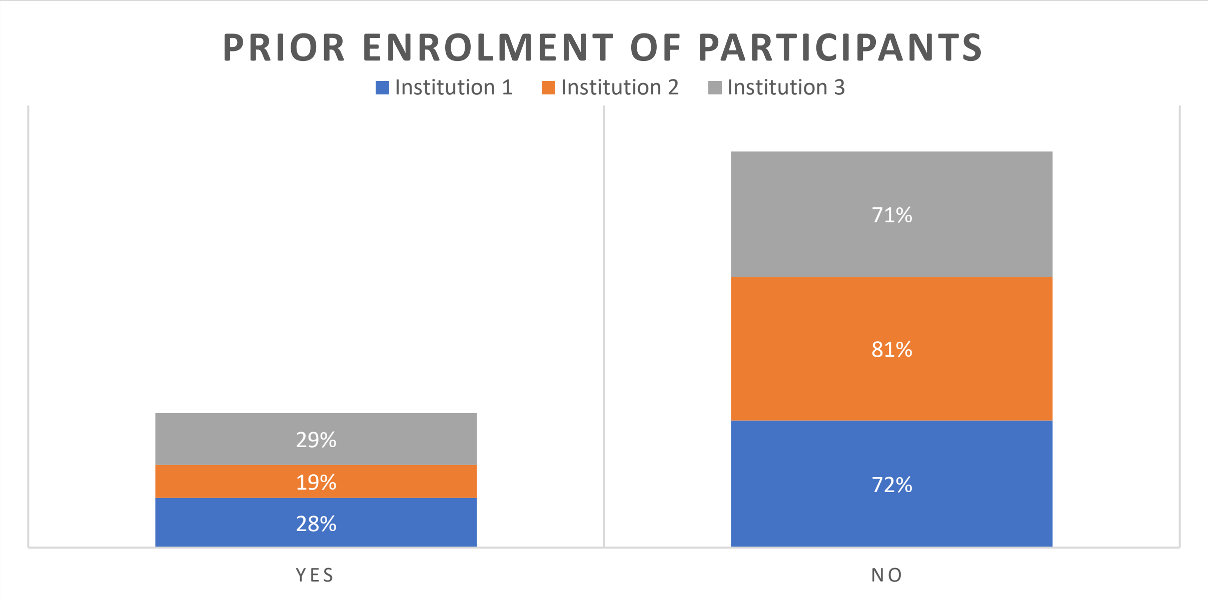


Figure 5.5: Prior Enrolment of Participants

The percentages of prior enrolment are relatively low, as depicted in Figure 5.5, indicating that most students decide on the quantity surveying programme as their first study option.

In a follow-up question, students who indicated prior enrolment were asked to indicate the field of study they were enrolled for before their current quantity surveying studies. Students (28%, n=57) at the first institution who had previously been enrolled indicated the following fields:

Table 5.4: Previous Enrolments Institution 1

Engineering	**9**
Accounting	1
BCom	1
Land Surveying	1
Town and Regional Planning	1
Construction Management	1
Environmental Sciences	1

Enrolments for any of these above-mentioned qualifications are relevant to the quantity surveying programme and profession to some extent. Notably, several students (9) indicated engineering as a prior enrolment at this institution.

The three students (19%, n=16) who indicated prior enrolment at the second institution were enrolled for:

Table 5.5: Previous Enrolments Institution 2

Engineering	**1**
Economics	1
Construction Management	1

Similar to Institution 1, these prior enrolments in the qualifications are relevant to the quantity surveying profession and programme. At the third institution (29%, n=24), students were enrolled for:

Table 5.6: Previous Enrolments Institution 3

BSc Agriculture Extended Programme	**1**
BSc Majoring in Mathematics and Finance	1
BSc Majoring in chemistry and Mathematics	1
Bachelor in Building Science	1
BSc Construction Science	1

The agriculture and chemistry qualifications are, to some extent, less relevant to the quantity surveying programme and profession. Still, the mathematics and finance programmes are relevant to the quantity surveying profession and programme. Building Science and Construction Studies are directly related and relevant to quantity surveying. (Of the six responses, one was invalid, indicating: ‘none’.)

In summary, from Theme 2, it is notable to report that very few of the first-year students have prior qualifications. There is, however, a small percentage of students who had been enrolled for other qualifications or programmes before enrolment in the quantity surveying programme, some of which are relevant enrolments. Hence, the experience gathered by students from their enrolment in other programmes might have contributed to their enhanced readiness for the quantity surveying programme and the building measurement module, primarily due to the relevance of their previous enrolments to the field of quantity surveying. Prior enrolments may influence students' preparedness, existing knowledge base, and experience level upon entering the quantity surveying programme. This assertion finds support in Ambrose et al.'s (2010) study (section 2.8.1), which underscores the role of prior knowledge in facilitating students' learning processes.

5.2.3 Theme 3: Perceptions and Quantity Surveying Education (included questions 9–10 and 13–16 of the survey, as depicted in Table 5.1)

In the third theme, data on various perceptions of the first-year students are reported. These perceptions include perceptions of their matric subjects and the support these subjects might lend to the quantity surveying programme. General perceptions about the quantity surveying profession were also tested and the reason for students' interest and entry into the quantity surveying programme are also reported in this section.

Students were asked to identify their matric subjects from a list. It is essential to establish the matric subjects students had, which might indicate prior knowledge and experience of the building measurement module. The data obtained show only two modules with 100% participation: English and Mathematics. This correlates with the entry and selection requirements of the quantity surveying programmes and general university admissions. Physical Science was another module most of the students had as a subject in matric; once again, this correlates with the admission requirements of universities and the quantity surveying programme.

Figure 5.6 illustrates students' matric subjects.

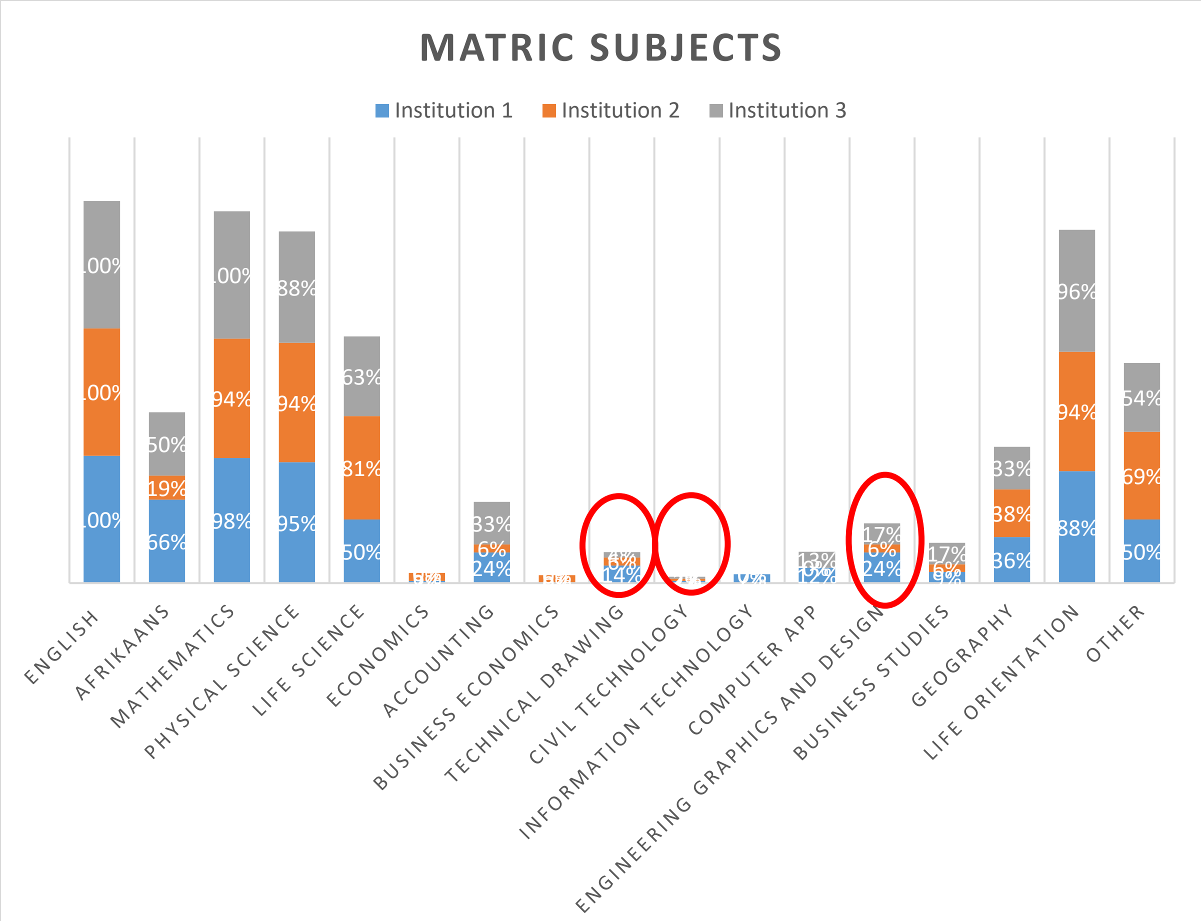


Figure 5.6: Matric Subjects

In addition to indicating their matric subjects, students were asked which matric subjects they thought would be most beneficial to them in the quantity surveying programme.

Most (89%) of the students from Institution 1 (n=54) indicated that they thought Mathematics would help them the most in the quantity surveying programme. Some students (48%) believed Physical Science would help them the most. A number of students also mentioned Engineering Graphics and Design (20%) and Technical Drawing (17%). Students (75%) from the second institution (n=16) also mentioned Mathematics as the most helpful module, with a single mention of Engineering Graphics and Design and Civil Technology, respectively. 25% of students mentioned that Physical Science would benefit their studies. Students from the third institution (n=23) reported Mathematics (65%) and Physical Science (74%) to be the most helpful in their opinion, with single suggestions for Engineering Graphics and Design, Civil Technology and Accounting, respectively. Clearly, students regard Mathematics and Physical Science as important supportive subjects in the quantity surveying programme.

Also, as part of Theme 3, students had to report on how they decided to study quantity surveying and report on their perceptions of the quantity surveying profession. Some of the answers to this open-ended question about their reason for entry include family relations in the built environment or construction industry, interest in the quantity surveying profession and the built environment. A few students indicated that professional career counsellors guided them to study the quantity surveying programme. Some students noted that they had initially considered quantity surveying as their secondary choice of study. This observation aligns with findings from Theme 2 of the survey, indicating that quantity surveying was not the primary preference for some students.

In an open-ended question, students were asked about their perceptions of the quantity surveying profession upon application to the programme. Students thought quantity surveying was mainly about:

1. Estimating/budgets/costs/financials of a project
2. Calculating the amount of materials/counting bricks
3. Measurements/site surveying, house plans/building plans
4. Construction
5. Managing property
6. Safety regulations

These perceptions (in no specific order) align with the responsibilities of a professional quantity surveyor as per the ASAQS (2020) mentioned in Chapter 2 (section 2.5.1).

However, some students did not have a clear idea of what the profession of quantity surveying entails. Some perceptions and comments include:

> *Counting bricks.*
>
> *I honestly did not know anything.*
>
> *Mining engineering.*
>
> *Inspection of buildings.*
>
> *It is not an office job, it's an on-site job, you work with people which means there a lot of communication and management.*
>
> *Making plans for building and ensuring that safe and good looking buildings are built, coming with different new styles to build.*

These data (in no specific order) show that some students did not understand the quantity surveying profession upon application to the programme, and their perceptions of the profession are, to some extent, inaccurate.

Interestingly, when asked whether the students' perceptions about the quantity surveying profession had changed since application, students reported the following: From Institution 1, the majority (66%) of students' perceptions and opinions did not change. From Institution 2, students' comments were quite the opposite, where 67% of the students' opinions changed. Students' opinions from Institution 3 are similar to those from Institution 1, whereby 71% of the students' perceptions have not changed.

These data reveal that students at the second institution initially possessed the least accurate perceptions of the quantity surveying profession during the application stage, with their perceptions undergoing the most significant changes upon commencing the quantity surveying programme (see Figure 5.7). Moreover, the data from Institution 2 resonate with the findings of Theme 1 regarding the age demographics of its students. Notably, Institution 2 hosts the highest proportion of 18-year-old students among its cohorts.

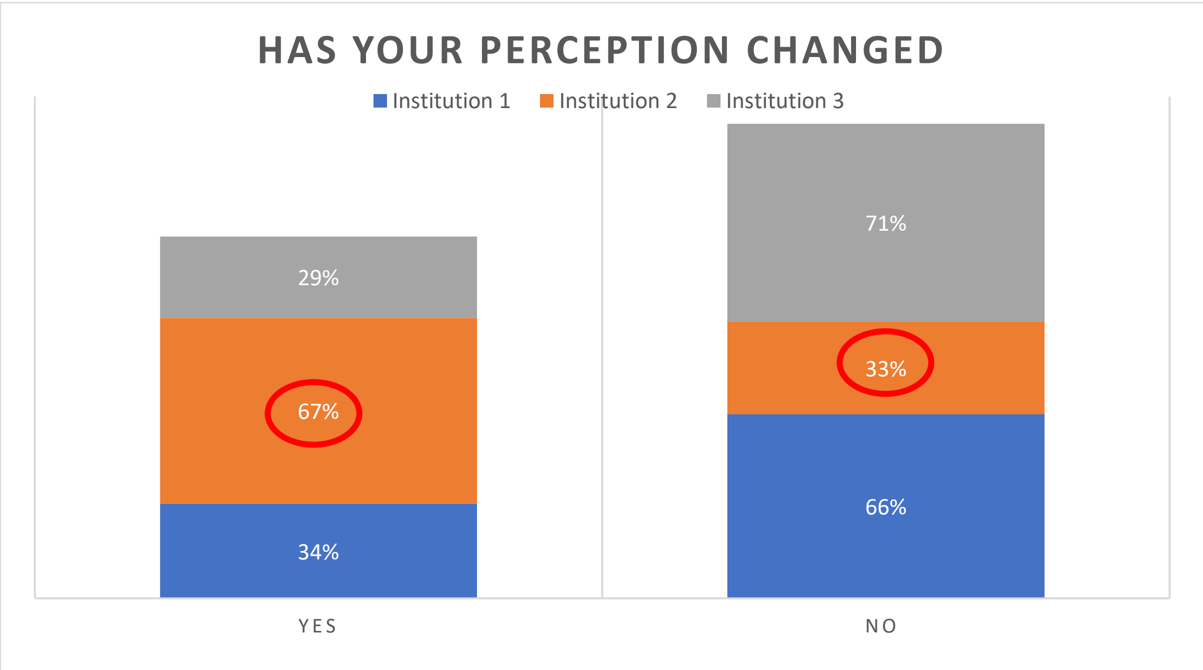


Figure 5.7: Change in Perceptions of QS Profession

When asked about an explanation of how perceptions have changed and why, students responded with the following:

> *It seems there's more to QS than calculating materials. There also are some measurements that have to be taken into consideration as well as calculating the materials before you can calculate the cost of the material that may be involved.*
>
> *It is not just counting bricks but working a lot with people.*
>
> *I am starting to love quantity surveying and get to realize that it is more that soil surveying.*
>
> *It is much more complicated.*
>
> *Quantity surveying is not all about calculating materials but also understanding floor plan and working with finances.*
>
> *It's more that buildings.*
>
> *My opinion has changed after my first week of lecturers where the lecturer made it clear on what this degree is all about.*

These data about how and why the students' perceptions have changed since the application indicate that students quickly realized that it was more than calculating materials, counting bricks and surveying soil. Rather, an understanding of floor plans and construction finances is necessary.

Some of the critical deductions from the third theme are that some matric subjects, such as Mathematics and Physical Science, can support the students in the quantity surveying programme. For specific support in the building measurements module, subjects such as Technical Drawings, Civil Technology, and Engineering Graphics and Design can be considered. However, from the data obtained from the students (see Figure 5.6), these subjects seem not to be popular among matric learners. Regarding participation in subjects such as Technical Drawing, Engineering Graphics and Desing and Construction Technology participation among matric learners are especially low. Reporting from Institution 1 (n=58), only 2% of the students had Civil Technology and 24% indicated that they had had Engineering Graphic and Design (EGD) as a subject in matric. Only 2% of students from the second institution (n=16), had had Civil Technology, and 6% of the students indicated that they had had Engineering Graphics and Design as a subject. Institution 3 (n=24), reported 2% having Civil Technology and 17% having Engineering Graphics and Design. One would think that subjects such as Technical Drawing, Engineering Graphics and Design and Construction Technology would assist in preparation for a programme such as quantity surveying and, more specifically, be supportive and provide some extent of knowledge to the building measurement module specific because of the relevance of the curriculum. (The subject of Technical Drawings was later replaced by the subject of Engineering Graphics and Design).

The Civil Technology subject's curriculum from Grade 10 to Grade 12 encompasses topics such as occupational health and safety, construction drawings, building materials and methods, and construction equipment. Furthermore, topics such as applied mechanics, construction, civil services, quantities, and joining of materials are also presented in the curriculum in secondary education in the Civil Technology subject (DBE, 2011a). The Engineering Graphics and Design subject encompasses topics directly related to the quantity surveying profession and programme. Drawing and scaling constitute integral components of its curriculum. Additionally, computer-aided drawing and design and discussions on the design process are included in the subject's syllabus (DBE, 2011b). However, these subjects might not be presented at all schools due to lack of resources or needs of the community.

Furthermore, students in the sample decided to study quantity surveying based on family relations, affiliations in the profession, built environment, or students with a keen interest or aptitude for the built environment. Some students, however, end up in the quantity surveying programme due to a failed first attempt at a different course or programme; in other words, it is their second option of study This is, however, the minority. When examining students' perceptions of the quantity surveying profession upon their application for the programme, it becomes apparent that certain misconceptions exist regarding the nature of the profession. Consequently, this underscores the necessity for more comprehensive guidance and information provision to prospective students prior to their admission into the quantity surveying programme. Addressing these misconceptions is crucial, as there appears to be a lack of clarity among prospective students regarding the reality of quantity surveying.

In the next section, data for Theme 4 are presented. Questions 11–12 of the baseline survey are implicated in these data, where students were asked to report on their perceived levels of preparedness upon university entrance for the first time, specifically registered in the building measurement module.

5.2.4 Theme 4: Perceived Preparedness Levels

Students were asked to rate on a scale of one to ten how prepared they felt to enter university (where 1 is the least and 10 is the most prepared).

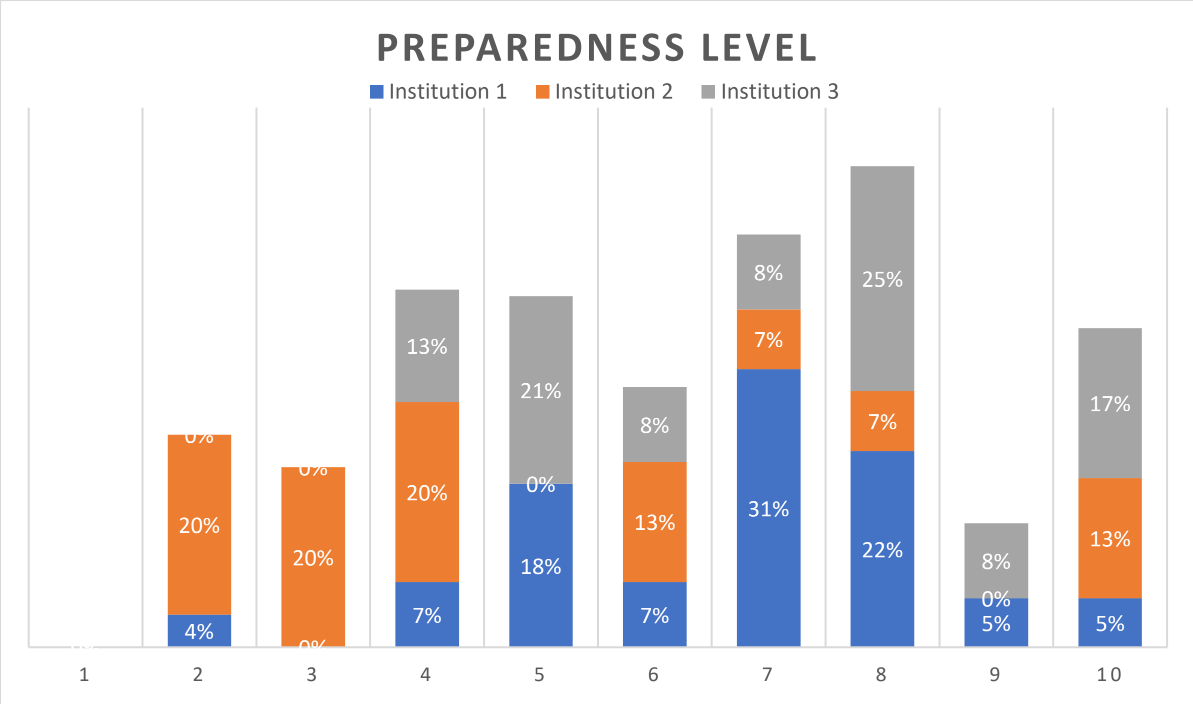


Figure 5.8: Preparedness Level of First-Year QS Students

These data show that only 32% of the students from Institution 1 scored on a level 8 or higher. 20% of students at the second institution scored on a level 8 and higher, and 50% of participants scored a level 8 and higher from Institution 3. This image (Figure 5.8) suggests that a small minority of students across all three institutions perceive themselves as adequately prepared for higher education entry. In Table 5.4 the different levels of preparedness among the different institutions are depicted.

Table 5.7: Preparedness levels

	Level 1-4	**Level 5-7**	**Level 8-10**
Institution 1	11%	56%	32%
Institution 2	60%	20%	20%
Institution 3	13%	37%	50%

Most students at Institution 1 scored in the middle range, with an average preparedness rate of 56%, falling within the range of levels 5–7, as depicted in Table 5.4. The majority (60%) of the second institution's students scored a level 4 or lower. Thus, students entering as first-year students at Institution 2 did not feel very prepared to enter higher education. It is also noteworthy that Institution 2 displays the highest percentage (63%) of matriculations in 2022 (see Figure 5.3), indicating that most of this cohort consists of recent high-school graduates. Students from Institution 3 exhibited the highest level of preparedness, with 50% of their students achieving a level 8 or above. Also notable is the institution's substantial number of prior enrolments in relevant programmes like engineering, potentially elevating their perceived level of preparedness (see Figure 5.5).

In a follow-up question to the students' self-reported sense of preparedness, participants had to motivate their answers qualitatively. Students from the various institutions, **feeling prepared and confident** (scoring on level 8 or higher), made the following comments:

> *I have experience with university so I know what to expect.*
>
> *I've been exposed into a University environment so I feel very much prepared for the 2023 academic year.*
>
> *Since last year I've already enrolled in University I was equipped and this year I am already aware of how to deal with pressure and a lot of work.*
>
> *I am ready and prepared to accomplish my dreams.*
>
> *Because I can't wait to learn about quantity surveying.*
>
> *I like to solve problems and like to study.*
>
> *I believe I am disciplined enough to take responsibility for my own life and my own academics at this point in my life.*
>
> *I am 90% prepared. I have already bought most of the required stationery and have already built my schedule.*

Students who have previously engaged with university education tend to feel more prepared, and those with elevated levels of self-motivation and keen interest also exhibit a heightened sense of readiness.

Students from the various institutions **not feeling particularly prepared** (scoring on a level 4 or lower) commented as follows:

> *I have never been exposed to any construction activity or work.*
>
> *Also trying to adjust to living alone and going to university is a big adjustment that I have to go through.*
>
> *I feel underprepared to be so independent, having no family close.*
>
> *I feel overwhelmed with where everything is; also, in high school, they still helped us a lot, but now we are on our own.*

I feel least prepared because everything is done differently from high school, and the pressure is worse.

My course contains modules I had never done in high school.

So far it's been nothing but pressure and stress from having to do modules that you have zero background.

I have no knowledge about quantities and the built environment.

I have no idea of anything in the building faculty the fact that I did not have EGD at school makes me struggle

It feels different and I'm not ready for the change.

From these data, to conclude the key findings of Theme 4 of the baseline survey, some students felt prepared and confident about entering higher education or university. Some students who demonstrated confidence and felt prepared to enter higher education might have experience and prior knowledge about the environment, and some students were excited and optimistic about the new opportunities. In contrast, some students felt less prepared when they entered university; they were stressed about the new environment and had limited or no prior experience or knowledge about the environment.

As discussed in Chapter 2, (section 2.3.1), the lack of preparedness among first-year students is a widespread national and international concern. Reports from various countries echo this concern, highlighting the challenges faced by first-year students entering higher education (Mudhovozi, 2012; Mouton et al., 2013; Thomas & Maree, 2021; Wollscheid et al., 2021). This study further substantiates these findings, indicating that institutions where students graduated from secondary school the year before university entry exhibit the lowest levels of preparedness. Conversely, institutions with a higher proportion of mature first-year students, who did not graduate the year immediately before university entry demonstrate higher levels of preparedness. This suggests that age may indeed influence students' preparedness levels, indicating that students may benefit from the experiences gained during the gap year(s) between secondary school graduation and enrolment in the quantity surveying programme.

5.2.5 Theme 5: (Prior)Knowledge and Experience

One of the critical objectives of the baseline survey was to assess students' initial understanding, prior knowledge, and experience concerning specific elements relevant to the quantity surveying programme. In question 16, students had to indicate and report if they had any prior knowledge, experience or exposure to the **construction industry** in general; then, in question 19, they were asked about prior knowledge, experience or exposure to the **profession of quantity surveying** specifically. In question 21, students had to indicate and report prior knowledge, experience or exposure in terms of using a **scale ruler and interpreting different scales,** followed by a question on their prior knowledge, experience or exposure to **reading and interpretation of construction drawings**. Supposing one can determine whether students have prior knowledge, experience or exposure in any of these areas, it might have a significant influence on the preparedness levels of students and provide a stronger foundation for students to build knowledge specifically in the building measurement module. It is crucial to emphasize that no predetermined level of prior knowledge, experience, or exposure is necessary or a requirment for entry into the higher education system or the quantity surveying programme. Establishing baseline or prior knowledge is crucial as it informs the lecturer's teaching approach, enabling them to tailor their methods effectively to meet the diverse needs and levels of understanding among students.

Prior knowledge, experience or exposure of the construction industry in general

Figure 5.9 shows that 62% of the students at Institution 1 indicated that they did not have any prior knowledge, experience or exposure of the construction industry. Students from Institution 2 indicated 94% without prior knowledge, experience and exposure of the construction industry. Institution 3 is on par with the first institution, with 63% of students not having any prior knowledge of the construction industry.

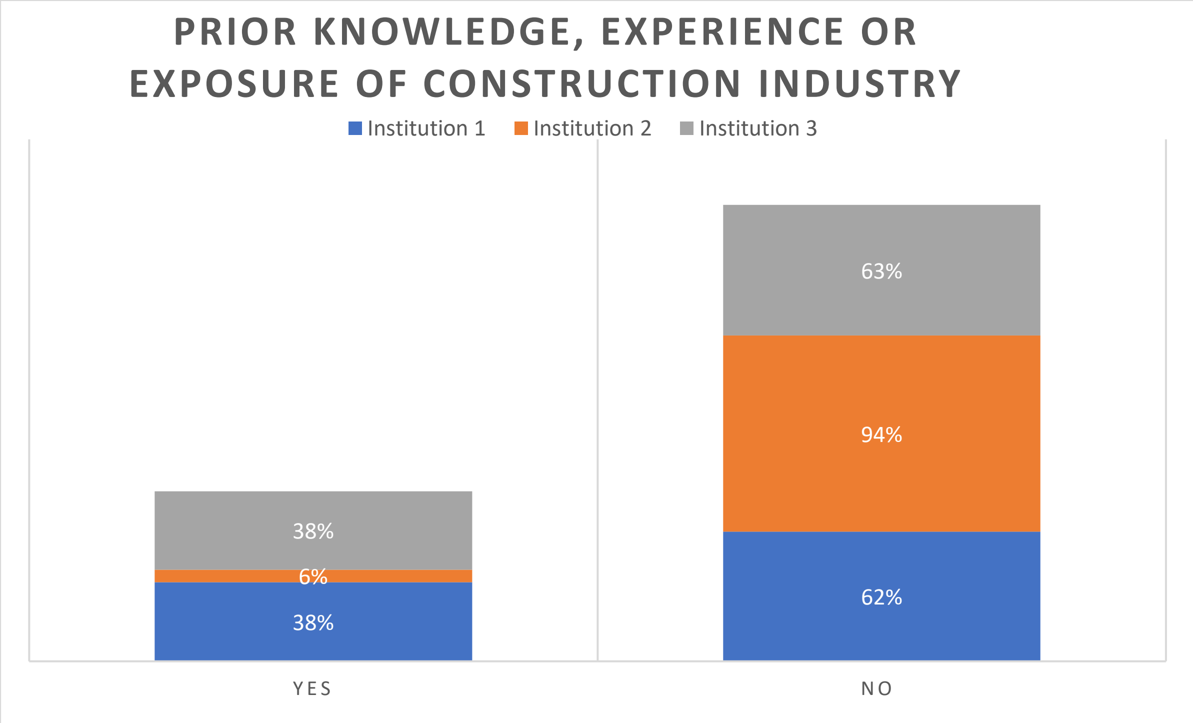


Figure 5.9: Prior knowledge, experience, or exposure to the construction industry

These findings suggest that most first-year students enter the quantity surveying programme with limited prior knowledge, experience or exposure to the construction industry in general. Once again, prior knowledge is not required; lack of prior knowledge is part and parcel of the first-year cohorts entering higher education for the first time.

Interestingly, Institution 2 stands out as the institution with the least prior knowledge, experience or exposure, which correlates with the findings of Theme 1, where this institution recorded the highest percentage of matriculation in 2022 (see Figure 5.3), indicating that the majority of its students are recent matriculants. Additionally, from Theme 2 data, Institution 2 shows the lowest percentage of prior enrolments, (see Figure 5.5) and its students' perceptions have undergone the most significant changes, as illustrated in Figure 5.7. The data exhibit correlation across the various data points.

Question 17 served as a follow-up query regarding the 38%, 6%, and 38% of students who indicated prior knowledge, experience and exposure to the construction industry. They were prompted to specify the extent of their familiarity with this sector. Various responses were provided, including:

> *My father is the manager at a construction company.*
>
> *My parents work in the industry.*

I job shadowed and worked for a few months.

Shadowed at a quantity surveyor.

I have worked in a roof truss factory on holidays, and visited numerous building sites.

I have done vacation work.

I've worked as plumber for 2 months at my uncle's plumbing company.

Family connections within the built environment, holiday work, and shadowing seem to be the extent of the students' prior knowledge, experience and exposure to the construction industry. These data correlate with data from Theme 3 of the survey, where students indicated that family relations in the built environment and interest in the profession were some of the reasons for them studying the programme.

In the next question, question 18, students were asked if they had any prior knowledge, experience or exposure **specifically to quantity surveying.** Figure 5.10. shows that Institution 1 indicated that 87% of the students did not have any prior knowledge, experience or exposure to the quantity surveying profession. Students from Institution 2 indicated 0% prior knowledge, experience or exposure of the quantity surveying profession, while students from the third institution indicated the same results as the first institution, with a 13% positive response to prior knowledge, experience and exposure to the quantity surveying profession.

Interestingly, in the previous question, students were asked if they had any prior knowledge, experience or exposure to the construction industry at large; from Institutions 1 and 3, students indicated a 38% positive response, but of the 38% only 13% were prior knowledge, experience or exposure to the profession of quantity surveying specifically. Be reminded once again that prior knowledge is not a requirement.

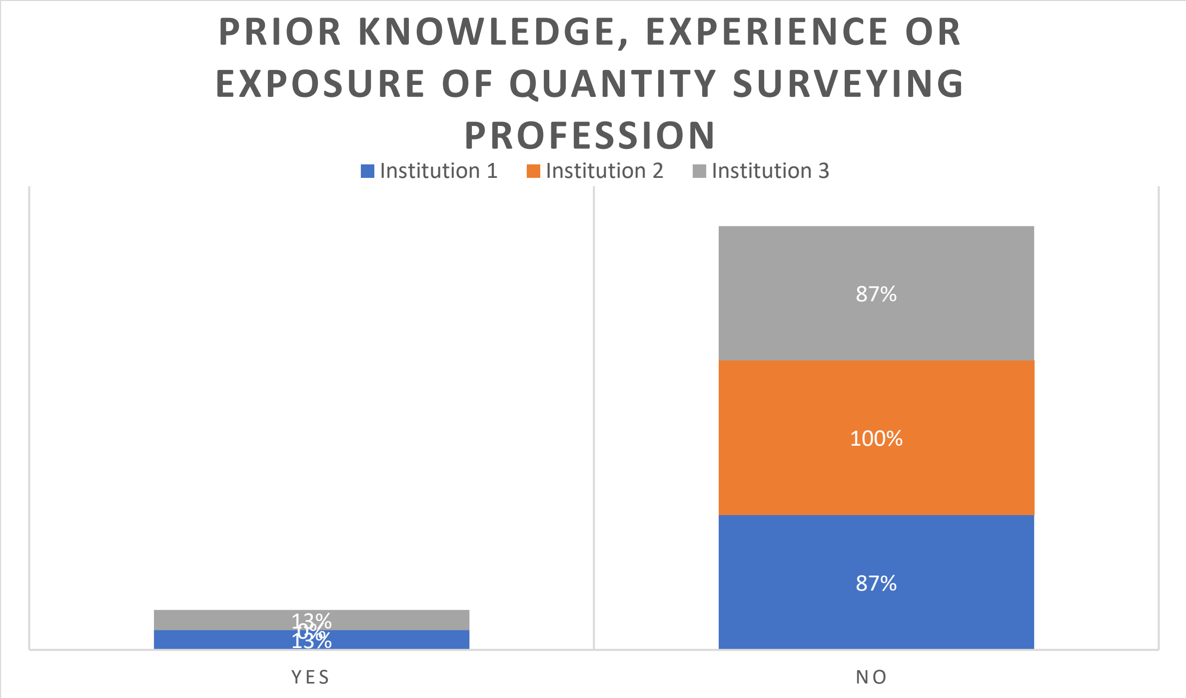


Figure 5.10: Prior knowledge, experience or exposure to the Quantity Surveying profession

Question 20, a follow-up question, asked where students might have been exposed to the quantity surveying profession. Some answers included:

> *From a young age, I joined my dad on some of the sites.*
>
> *I did some shadowing with a professional quantity surveyor.*

The next question determines prior knowledge, experience or exposure **to using a scale ruler or read and interpretation of different scales**. According to data from Institution 1, 51% of students possessed prior knowledge, experience or exposure to scale rulers and interpretation of scales. Institution 2's data indicate that 44% of students had previous experience of scale rulers, while only 26% of students at Institution 3 possessed such knowledge. As depicted in Figure 5.11, students at Institution 1 exhibited the highest proportion of prior knowledge, experience or exposure to using a scaler ruler and interpreting scales. This institution also boasts many past enrolments in engineering programmes, suggesting a potential correlation between these factors and the institution's notably strong performance (see Figure 5.5).

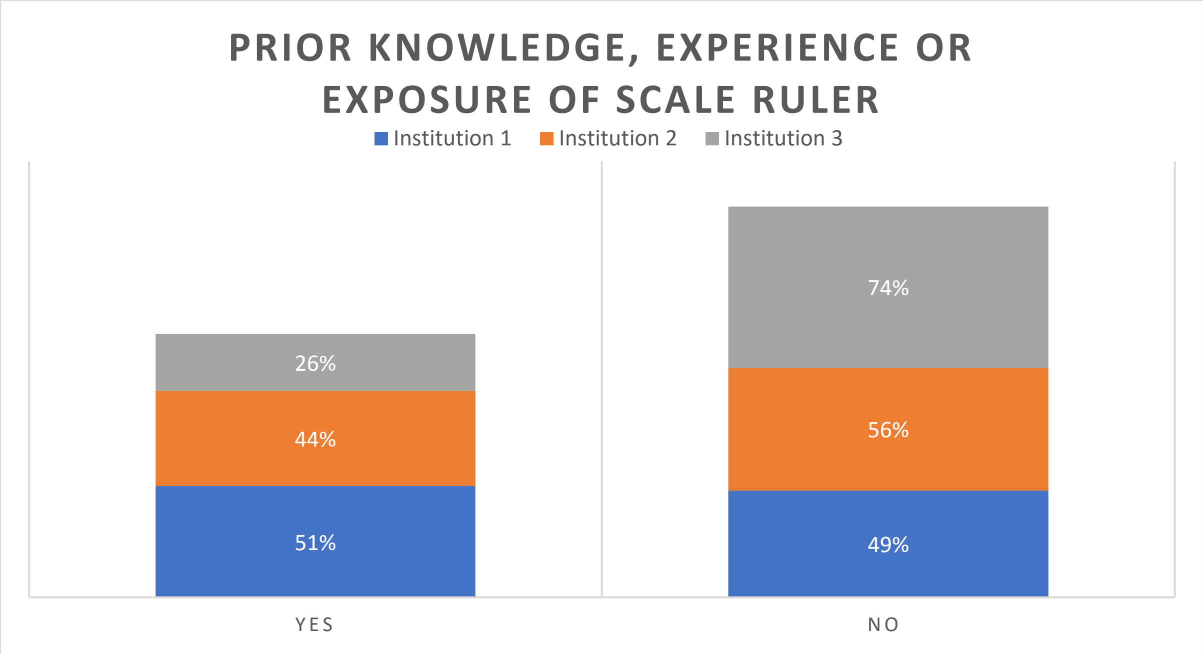


Figure 5.11: Prior knowledge, experience, or exposure with a scale ruler

The next question aimed to ascertain participants' **prior knowledge, experience, or exposure about the reading and interpretation of construction drawings.** (Figure 5.12). Students were asked to indicate if they had any prior knowledge or experience in the reading and interpreting construction drawings. 60% of students from Institution 1 indicated that they did have prior knowledge, experience or exposure to reading and interpretation of construction drawings, 25% of students at the second institution have prior experience, and 33% of students from the third institution indicated prior experience/exposure to reading and interpretation of construction drawings. It is interesting how high the experience of Institution 1 is. This might be due to the previously enrolled engineering students entering the quantity surveying programme, as indicated earlier in this section.

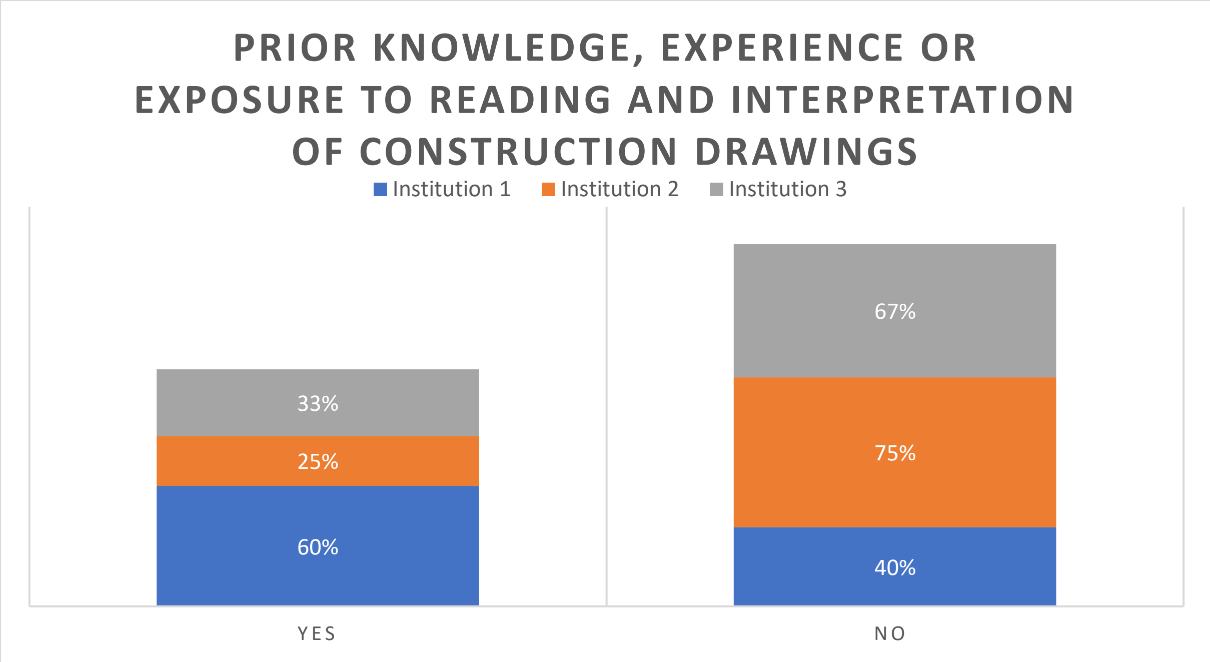


Figure 5.12: Prior knowledge, experience or exposure of construction drawings

In the next section of the baseline survey, students were asked to report on their **general knowledge about the profession of quantity surveying** on a Likert scale from 1–10, (where 1 is the least and 10 is the most knowledge).

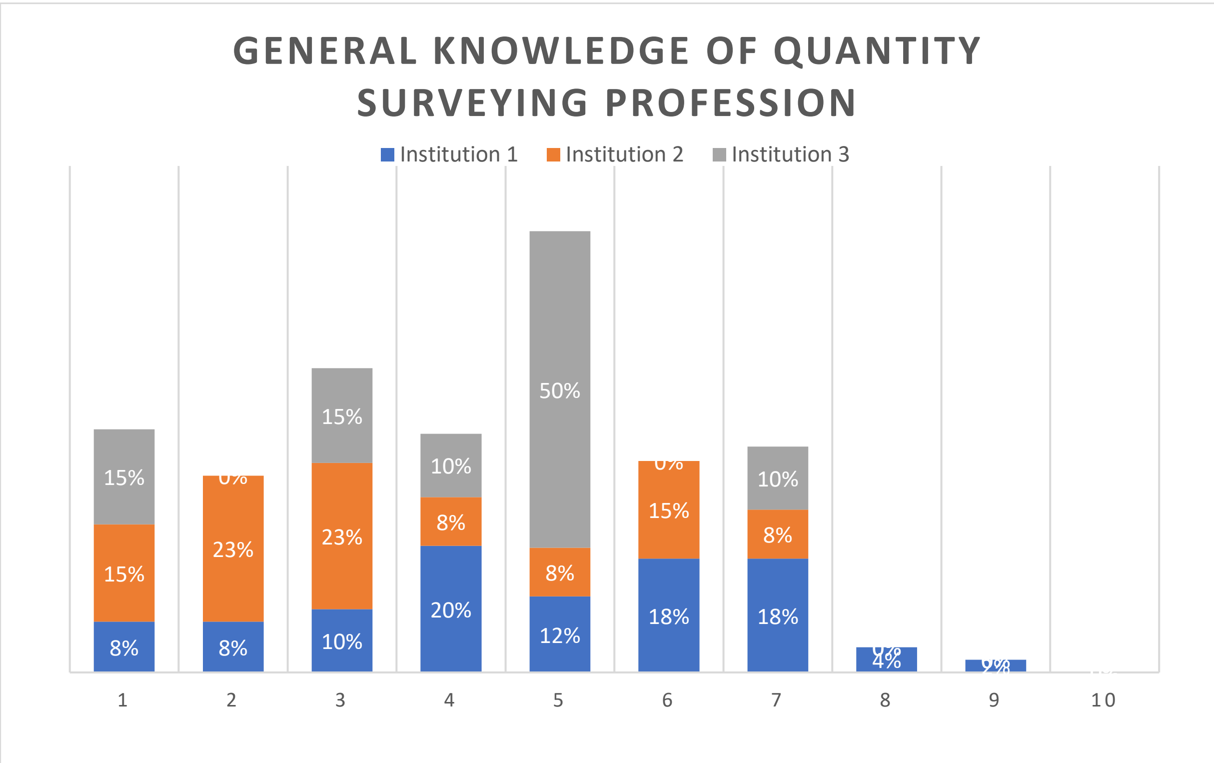


Figure 5.13: General knowledge of quantity surveying profession

Figure 5.13. shows that 46% of students at Institution 1 scored their knowledge about the quantity surveying profession on level four or lower. In contrast, the majority (69%) of students at Institution 2 scored their knowledge on level 4 or lower. At Institution 3, 40% scored their knowledge on a level 4 or lower. These data substantiate the observation that students entering the quantity surveying programme generally possess a limited understanding of the profession. This finding correlates with Theme 3, where students' perceptions of the quantity surveying profession revealed prevalent misconceptions.

In the last section of the survey (questions 25–31), the students were asked to rate their current knowledge of items related to and presented in the first year in the building measurement module within the quantity surveying programme. Students had to rate their current level of knowledge on a Likert scale from 1 to 10 (where 1 is the least and 10 is the most knowledge). Table 5.6. summarises the findings in terms of the mean scores calculated, and then the items are ranked accordingly.

Table 5.8: Building Measurement Module Knowledge Areas

	Institution 1 N=54			Institution 2 N=15			Institution 3 N=23		
	N	Mean	Ranking	N	Mean	Ranking	N	Mean	Ranking
Reading a scale ruler and the interpreting different scales	54	3.2	1	15	2.73	4	23	2.38	4
Using a scale ruler to take measurements from a construction drawing		2.98	5		2.8	3		2	5
Construction drawings / buidling drawings for example sections, elevations, scale of drawing		3.19	2		3.2	2		2.39	3
Different building materials used in the construction of buildings		2.81	6		2.8	3		2.61	2
Elements and components of a structure such as foundations, superstructure, roof, finishes		3.04	4		2.73	4		2.7	1
Duties, roles and responsibilities of vairous professionals in the built environment such as architects, engineers, contractors		3.13	3		3.4	1		2.61	2
The course of a construction projects, also known as a construction timeline		2.74	7		2.57	5		1.73	6

Some data stand out from the data obtained and presented in the table above. For example, *'Reading a scale ruler and interpreting different scales'* does not seem to be a problem for students from the first institution, as their mean score ranked this item first. Data and mean scores obtained from the other two institutions ranked this item fourth. The significant disparity in the data could be attributed to the influence of engineers, as highlighted in Theme 1 and other previous sections.

The next item that stands out is the knowledge of *'Different building materials used in construction'*. Data and mean scores obtained from Institution 2 ranked this item second, whereas the first institution ranked this item in the sixth position. There is a significant disparity in the results.

It seems students from Institution 3 know the most about *'Elements and components of a structure such as foundations, superstructure, roof, finished',* as this item is ranked first based on their data and mean scores. Data from Institutions 1 and 2 ranked this item fourth, once again a big disparity in the data.

Knowledge on *'The course of a construction project, also known as a construction timeline'* seems to be on the downside at all three institutions as this item is ranked seventh, fifth and sixth by the students in the different cohorts. Thus, students are unaware of the course of a construction project also known as the construction timeline or stages in construction.

Students from all three institutions seemed to understand the *'Duties, roles, and responsibilities of various professionals in the built environment such as architects, engineers, and contractors'* in the construction industry, as this item was ranked third, first and second based on the mean scores. These data imply that students are knowledgeable about the built environment and related stakeholders.

At this point, it is challenging to provide a definitive explanation for the variation in the data regarding the knowledge levels of specific elements within the building measurement module as depicted in Table 5.6. This discrepancy may stem from differences in the curriculum composition and the sequencing of learning units and outcomes across the different institutions. Additionally, since the survey was conducted during the initial weeks of an academic year, it is conceivable that some of the topics covered in the module were addressed later in the semester or academic year, potentially influencing students' understanding at the time of the survey.

As highlighted earlier in section 5.2, the baseline survey was meticulously crafted to determine the baseline knowledge and readiness levels of first-year students entering higher education, particularly within the quantity surveying programme and the building measurement module. Understanding the baseline knowledge of students is crucial as it serves as a departure point for lecturers. Through this assessment, we can ascertain students' prior knowledge, significantly shaping their learning journey. Relevant prior knowledge can notably amplify their preparedness for the subject matter, enhancing their overall readiness.

Chapter 3, section 3.3.1 emphasizes the pivotal role of prior knowledge in learning, particularly within a constructivist framework. It highlights educators' need to recognize and incorporate students' existing knowledge, underscoring its influence on comprehension and the learning process. At the same time, prior knowledge can serve as a foundation for acquiring new insights, while its inadequacy or irrelevance can hinder comprehension, necessitating effective assessment and activation strategies by educators (Davis & Arend, 2013; Gabriel, 2008; Ambrose et al., 2010). Various methods are suggested for assessing and activating prior knowledge to facilitate meaningful connections between new knowledge and existing knowledge. Effective utilization of prior knowledge enhances learning outcomes, but its success depends on the nature of students' prior knowledge and lecturers' adeptness in leveraging it.

In summary of Theme 5, it can be concluded that first-year students entering the quantity surveying programme have limited prior knowledge, experience or exposure to the construction industry, but even more so for the quantity surveying profession, where minimal knowledge, experience and exposure are reported. Students seem to be acquainted with the use of a scale ruler and interpretation of scale, and the reading and interpretation of construction drawings are, to some extent, known by students, especially students at Institution 1. Students' general knowledge about the quantity surveying profession is significantly low across all institutions. In the last section of theme 5, it is interesting to notice the disparity in knowledge between the three institutions regarding specific key topics in the curriculum of the building measurement module.

The data extracted from the baseline survey identified five themes: student demographics, student profile, students' perceptions of quantity surveying education and the profession, preparedness, and prior knowledge and experience. The participation of the sample across the three participating institutions yielded valuable insights. The subsequent section presents the data gathered from focus-group discussions conducted among first-year students.

5.3 FOCUS-GROUP DISCUSSION RESULTS

The data gathered from the focus-group discussions are now presented. First-year students from four institutions were invited to participate in these discussions, as discussed in Chapter 4, section 4.5.7.2. The focus-group discussions took place in the second half of the first semester, 2023, leading to the exclusion of Institution 4 from these group discussions as it offers the building measurement module in the second semester. Students were invited to volunteer to participate in the focus-group discussions via their lecturer on the LMS. 31 students from the first institution, 15 from the second institution, and 9 from the third institution volunteered to participate in the focus-group discussions. As depicted in Table 5.7, Institution 5 had no volunteers to participate in the focus-group discussions.

Table 5.9: Participation Summary for Focus-Group Discussions

	Total number of students registered for the building measurement module	**Total population of QS students (where known) registered in the building measurement module**	**Total number of students who participated in focus-group discussions**
Institution #1	137	74	31
Institution #2	76	45	15
Institution #3	26	26	9
Institution #5	Unknown	Unknown	0

The primary focus of these discussions was to explore students' experiences upon entering university and their encounters with the building measurement module precisely and to discuss challenges faced during the initial stages of their first year in higher education. Students also reported on the current learning and teaching approaches and their effectiveness. The face-to-face, focus-group sessions involved asking students nine questions and lasted approximately 60 minutes. The groups comprised between 9 and 11 students each. The discussions were recorded and transcribed, thematically grouped and analysed and the data are presented in the subsequent sections.

The analysis of data extracted from the focus-group discussions identified four overarching themes: 1) Reasons for studying quantity surveying, 2) (Under)Preparedness, 3) Current experiences, and 4) Challenges. Data are presented per institution in the subsequent sections. The themes that emerged from the data were identified through a structured analysis process. The qualitative data from the dicussions were manually grouped into themes by identifying recurring patterns. This approach provided a systematic way of organizing and interpreting the data.

5.3.1 Theme 1: Reasons for studying quantity surveying

As an introductory question, students were asked why they enrolled for the quantity surveying programme. Many of the students from the first institution indicated that they were studying quantity surveying mainly due to family associations in the quantity surveying profession or family relations in the built environment at large. A few students indicated they sought career advice and were recommended to study quantity surveying. A group of students also mentioned quantity surveying as their second study option. The quotes below illustrate some of the reasons students gave why they are studying quantity surveying:[3]

> P7: *… my father is a practising as a QS, so then I decided to also study it …*
>
> P1: *… My dad and sister are both quantity surveyors …*
>
> P2: *… one of my friend's uncles is a QS in New Zealand and some of my dad's clients are also QSs …*
>
> P6: *… My whole family is in the construction industry…*
>
> P1: *… I saw a guy here at the university that does what you choose, he helps you with that and he showed me Quantity Surveying and when I went to shadow…*
>
> P3: *… I started with Engineering, I so struggling a lot and juggle a lot of things and my interest was just slowly dying, so I was also slowing dying. But my father who is an architect, he, he told me about Quantity Surveying, that I might be interested in…*
>
> P2: *… I also started out in Engineering but I wasn't mentally strong enough for that challenge, so I took a break and then I also wanted to keep doing a career in construction because I really love it. And a friend of mine that I really look up to studied Quantity Surveying…*

Likewise, similar to the first institution, several students at the second institution mentioned having family members who pursued quantity surveying, which served as a motivating factor for their enrolment in the programme. Additionally, a number of students expressed interest in the programme, leading them to ultimately decide to enrol.

> P1: *… I've always been interested in buildings ....*
>
> P2:*… two of my siblings did QS …*

[3] The pseudonym, P, is created as an acronym for participants.

P1: *… there was this lady, then my teacher introduced her that she was one of her learners and now she is doing quantity surveying and she told us the overall part, what quantity surveying is all about. So, I was kind of interested and I applied …*

P2: *… there was this guy who was doing Quantity Surveying. I became interested …*

Students at the third institution revealed that their decision to pursue this programme stemmed from an interest in the subject matter, while others cited family ties and connections within the built environment as influential factors. Additionally, some students at Institution 3 mentioned that the course was their second choice of study.

P6: *… Personally, I've always wanted to be part of the construction team …*

P3: *… I've always had a fascination with the building environment…*

P9: *… my love for construction started when I was young …*

P5: *… the reason being for applying for Construction is that my dad is also in the industry …*

P3: *… I was rejected for engineering, so I ended up here, but the more… that there's a reason behind why I'm still here, because I've always had a fascination with the building environment …*

Taken together, first-year students predominantly choose the field of quantity surveying influenced by family relations and associations in the quantity surveying profession or within the built environment. Students also choose quantity surveying due to a keen interest in the subject matter. A few students also indicated that career advice had driven them to apply for this programme. Some students apply for quantity surveying as a second career option. These findings align with the data from Theme 3 of the baseline survey, as students similarly highlighted family connections and personal interests as key drivers for choosing this programme.

The following section presents data from the second theme, exploring students' perceptions of their preparedness for higher education.

5.3.2 Theme 2: Preparedness

The second question for discussion among the group was the issue of preparedness upon entry into higher education after matriculation. Some students from Institution 1 indicated they initially felt prepared to enter higher education, but when they arrived at the university, they realized they were unprepared. Students also mentioned that there is a big gap and jump from school to university; they also mentioned that there is no matric subject to help them prepare for the building measurement module, the learning curve is quite steep, and the pace of learning and teaching is much faster than at school. They also mentioned that they had more responsibilities as students and were no longer around their parents or friends. All these factors contributed to the feeling of underpreparedness among the students.

Some of the answers from students to this question include:

> P10: *... I felt very prepared and then came here and got a shock ... You come in with confidence, then the first week it is broken ...*

> P3: *... Definitely. I wouldn't say there's a big jump, maybe a small jump but I think the learning curve is extremely steep... the tempo, the work and the content, the amount, it's, it's a lot and it's very hard to adjust for it ...*

> P2: *... You are in like an environment where there's someone to lean on all the time, to, for most of us it's, you're in a new city by yourself, you're in a new environment, you barely know anyone ...*

> P1: *... I don't think there are really any high school modules that can prepare us for this ...*

The majority of the students at Institution 1 indicated that they felt that high school needed to prepare them more for higher education and felt that they were 'babied' at school, as mentioned by P2: *... in my high school you were really babied ... this really is a wakeup call...*

Students from the second institution also indicated that they were unprepared for higher education and experienced a big jump from school into higher education. Students were in agreement that the high school had not prepared them enough for the transition into higher education, and some mentioned that everything was new; they felt lost when they entered university for the first time. Students made the following comments in this regard:

> P6: *... It was a huge jump that I was never prepared for...*

> P1: *... I went to a technical school where I did Civil Technology where I sort of got a gist of surveying. But when I got here, it's like, it was completely different to what I thought I was getting myself into ...*

> P5: *... I'm not prepared at all ... I felt like I'm a bit lost and I had to like figure everything out from scratch ...*

Students at the third institution also agreed that the secondary school system did not prepare them well enough to succeed in higher education, with comments such as

> P5: *... No, not even close ...*

> P2: *... I feel like also, like during high school you're spoon fed ...*

> P8 *... 0% prepared ...*

Institution 3's students mentioned that the building measurement module is difficult and the fact that they do not have any prior knowledge, which the lecturers expect or assume, makes it more challenging, as mentioned by

> P4*… and then teach me like I'm supposed to know it because I don't have background …*
>
> P7*… and sometimes the way that the work would be explained, it would almost come like as if we already have experience in the field, then I'd sit there and like I've never heard that word in my life …*

These findings align with the research observations of Tunji et al. (2016), who studied learning difficulties in building measurement, noting that one challenge students face is lecturers assuming prior knowledge, which can be frustrating and hinder learning. The frustration from students arises when lecturers assume familiarity with certain concepts. Chapter 3 (section 3.3.1) also emphasizes the importance of assessing prior knowledge to ensure students are taught at their appropriate level, underscoring that not all previous knowledge is beneficial (Davis & Arend, 2013; Gabriel, 2008; Ambrose et al., 2010). Lecturers must recognize this and assess students' existing understanding to tailor instruction effectively, as inadequate or irrelevant prior knowledge can distort concepts and foster misconceptions, hindering the learning process.

The feedback from students across all three institutions aligns closely with a unanimous sentiment that their respective secondary schools prepare them inadequately for higher education. This observation becomes particularly noteworthy when compared with the findings presented in Theme 4 of the baseline survey, which similarly highlight that a significant number of students across all three institutions did not feel adequately prepared for university or higher education entry.

There is a significant issue, whereby students might have unrealistic expectations about their preparedness or the higher education environment and it is discernible from the students' responses that they are unprepared to enter higher education. Students also have expectations of readiness, but they realise they are not prepared enough upon entry as mentioned by one student

> P1:*… I thought I was ready … and I felt prepared … and then I came here and was like, no, no…*
>
> P10: *… I felt very prepared and then came here and got a shock …*

Following the discussion on preparedness within the groups, the factors contributing to underpreparedness were addressed. Students from the first institution noted that they had fewer responsibilities during high school and lacked adequate instruction in time management skills. Additionally, uncertainty about what to expect in university was identified as another factor contributing to their underpreparedness. The quotes below illustrate some of the students' responses:

> P8: *… So, academically I think school … actually babies you a bit more than, than you expect. Like, I thought, no, I'll be fine, you know, I was in a big school, they said they are preparing us for varsity and everything but … I guess they tried their best …*
>
> P1: *… in high school, you are not taught any time management skills …*
>
> P7: *… the unknown sort of makes it the most challenging. Because if you, if you don't figure it out yourself, no one's going to like, be like, listen, you have to figure it out, come now …*
>
> P7: *… For me, I think like living at home, everything was done, like she said, my only focus was on school, so now like currently at university, I have to do laundry by myself, I cannot even cook …*

Students from Institution 2 indicated that more guidance on career paths and occupations would have been beneficial and might have aided in their preparedness to enter higher education. They also mentioned the effect of the COVID-19 pandemic might have on their readiness for higher education. Some of the responses include:

> P1: *… From my own perspective, I feel like they should have given us a brief about, OK, actually would have guided us in terms of our career choices, maybe then it would have given us a better idea of what type of career we want to be in, enrolled in …*
>
> P2: *… Perhaps ma'am, isn't it kind of like the, the fact that we were affected by COVID that the school didn't really prepare us well for university?*

Students from the third institution reported that they struggled with the workload and mentioned that, at school, their schedules were managed, whereas at university, there is not a lot of communication between lecturers with regard to the schedule.

> P2: *… I feel like the difference with the workload, in high school … I think, teachers were in the same staff room, they could have conversations, maybe about scheduling. Here, everyone dishes out work like you're only doing their own course …*

In summarizing Theme 2, it becomes apparent that students perceive their secondary education to be inadequate in preparing them for entry into higher education, consequently contributing to their underpreparedness. This observation finds support in various studies such those by Mototi (2010), Mudhovozi (2012), Mouton et al. (2013), Monnapula-Mapesela (2015) and

Roman et al. (2016), all of which underscore concerns regarding the readiness of first-year students entering higher education. Monnapula-Mapesela's (2015) investigation into students' perceived preparedness revealed unrealistic expectations among first-year students upon entering higher education. Similarly, Strydom, Kuh and Loots (2017) highlight the phenomenon of students overestimating their preparedness and emphasizes a gap between students' perceived readiness and the actual difficulty level they encounter.

In the subsequent section, the third theme is introduced, focusing on the experiences of first-year students in higher education with specific reference to the building measurement module, which is core to the quantity surveying curriculum.

5.3.3 Theme 3: Current Experiences

The third theme derived from the data collected during the focus-group discussion centres around students' current experiences at higher education in quantity surveying programme and specifically in the building measurement module.

At Institution 1, students expressed positivity towards the building measurement module, finding it engaging and appreciating its practical aspects. They commended the lecturer for her high level of engagement and ability to remember many students' names, which significantly assists in the class's engagement. All students acknowledged the importance of the building measurement module and its relevance to the broader field of quantity surveying. The students described typical classes lasting around two hours, featuring a blend of theoretical lectures followed by practical examples. The lecturer actively involves students during example discussions, and supplementary resources such as PowerPoint presentations and videos are available. Groupwork is also incorporated, allowing students to discuss measurement examples collaboratively with the lecturer's guidance. Overall, students appreciated the interactive nature of the classes and valued the opportunity to apply theoretical concepts to real-world scenarios.

Some of the comments about students' current experiences of learning and teaching in the building measurement module included:

> P11: *... Usually the theory is explained in the first hour and then do a bit of practical ....*
>
> P10: *... It's mostly PowerPoint slides ...*
>
> P9: *... For practical work, she uses a camera on the desk and like highlight it with a pen ...*

P11: *... And she gives out like the floorplan of something that we are measuring from, and she usually just goes through it on the computer in Excel and engage us ...*

P2: *... So, the first lecture, the lecturer explains how to measure or whatever the day's work is on, and then the second lecture is, we do it ourselves and then if we need help, we can call her but we don't always get help. But then, she puts us in groups, then we work together, so then it's easier. So, if we can help each other, because there is, there is students that actually understand the measurements, so then they can help us ...*

P10: *... Well, whenever ma'am gives us like an example to do after she like told us the theory and like give us like or like went through an example ...*

Upon querying students from the first institution about the efficacy of the existing teaching approaches, they expressed satisfaction, particularly with hardcopy handouts, group discussions, and lecturer engagement and mentions P1: *... I feel very engaged and with how the lecturer structures the classes, I feel I want to participate ...*

At Institution 2, lectures are held once a week for approximately one and a half hours. Additionally, practical sessions occur every other week, during which the lecturer distributes hardcopies of measurement examples and conducts in-class discussions. Furthermore, tutorial sessions or student assistant sessions are available throughout the week, providing opportunities for discussing practical examples. The lecturer also uses drawings, diagrams and images to illustrate certain principles. Students describe the lessons as:

P3: ... I think she mostly uses PowerPoint and she does explain a lot, so she'll give us papers for us to do the exercises with her in class as an example, then we can revise it ...

P6: ... But she also does like use the board and actually draw most of our diagrams, so we get a better understanding of everything ...

Students from Institution 2 demonstrated a clear understanding of the significance and importance of the building measurement module and its relevance to the quantity surveying profession. Several students highlighted the connections between Engineering Graphics Design and Civil Technology, as matric subjects, and the building measurement module, noting how their experiences and backgrounds in these modules facilitated their understanding and application of concepts within the building measurement module. (Unfortunately, Theme 3 of the data presentation from the baseline survey highlights a concerning lack of interest displayed by students in these matric subjects.)

Some of the comments included:

P2: ... I feel like Engineering Graphic and Design should be a requirement ...

P4: … I have like a background because I was doing Civil Technology in high school …

P4: … because I was doing Engineering, Graphic and Design where we had to do the measurement, so l learnt a lot about measuring and doing the drawings, so it's easy for me like to interpret the drawing …

Students at the third institution also indicated positivity towards the building measurement module and some students mentioned the following:

P8: *… Like it's excellent…*

P2: *… every time, when I come into this class, I feel happy…*

P4: *… on a Friday, I wake up just to come here and I'm never late.*

Students also reported that tutorials, worksheets and reflections from part of their learning and teaching approach. Students seemed positive about this module, and they did understand the importance of this module related to the quantity surveying profession. Students also demonstrated an understanding of the importance of supporting modules such as Building Science and mentioned the following:

P4: *… I remember the time we went on site, we had previously spoke about like the foundations and stuff, but then I hadn't like really grasped it initially. But then when we went on site, ma'am like did give us like a clarity about what's happened. I feel like that's when I actually understood what foundation actually is. So, I think it kind of … even, even though we have like the Building Science module, this one kind of gave like a better clarity about what's happening …*

Data from Theme 3 demonstrate that the teaching approaches employed by the different lecturers incorporate some elements of constructivism. Key components such as active learning, social interaction and the application of real-life scenarios are integral to the constructivist approach in learning and teaching. Across the various institutions, lecturers adopt similar strategies, with the first and second institutions sharing many similarities in their teaching approaches, including a combination of theoretical and practical sessions with active student engagement. Additionally, it is noteworthy that students expressed enjoyment and appreciation for the active engagement within this module. This agrees with the findings of various researchers (Ekundayo et al., 2021, Farrow & Wetzel, 2020; Mojtahedi et al., 2020; Lee, 2013) about the importance of active learning and student engagement in construction education, where students prefer active engagement and experiential learning.

The following section introduces the fourth and final theme, derived from the data obtained from the student discussions, which focus on the specific challenges first-year students encounter in the building measurement module.

5.3.4 Theme 4: Specific Challenges

Reporting from Institution 1, although students enjoyed the module, they noted various challenges with the complexity of the theory and the fast pace of instruction. Many students found this module difficult and challenging mainly because of a lack of prior knowledge, the new content, and especially the introduction of new concepts. Students also mentioned that they struggled with 3D and 2D concepts and visualization. Students also mentioned that due to large class sizes, it could take a while for their questions to be addressed, but when they are, the explanations provided are clear.

Some of the comments of the students with regard to challenges include:

> P3: *… the theory is very hard to like figure out …*
>
> P7: *… everything is new in this module because you don't have anything close to it in school …*
>
> P6: *… it's quite a difficult module, you have to spend a lot of time trying to understand it …*
>
> P7: *… I think there are too many students because our lecturer don't come out to everybody's questions in a lecture …*
>
> P3: *… I think she needs to slow down … I feel like she goes a little bit too fast …*
>
> P8: *… I think to understand it on a 2D image, it was a bit difficult for some students …*

Although not presented as challenges specifically, students suggested potential improvements, such as incorporating site visits for the module, an increased frequency of assessments, provision of worksheets, examples and feedback. They also proposed dividing classes into smaller groups to facilitate more personalized learning experiences. Additionally, they advocated tutorial sessions featuring additional support from senior students or tutors to address questions effectively and they mentioned the utilization of videos and 3D models for content delivery. Some of the comments included:

> P3: *… when we go to site we actually see it in real life and it kind of helps you figure out what's happening …*
>
> P5: *… maybe splitting us in two groups … to focus more on the individuals …*

P2: *… So, it's not just the lecturer, it's also a, the student that can do the work that helps us with the tutorials. So, if they can get two or three students in the class with the lecturer, that's four people helping 110 students, that is so much more efficient than just one lecturer.*

P5:*… watching those videos and I really understood … I find it very hard to like grasping this work. So, so I would really appreciate it if she had more videos …*

Students from Institution 2 reported that they found the module challenging and mentioned the following specific challenges related to the building measurement module:

P2: *… It can be too fast …*

P3: *… And you can't keep up with the notes …*

P5: *… Mostly, for me, it's the theory … The slides helps us and also the videos but a textbook would really help …*

P1: *… I'm unfamiliar with using like lecturing gadgets … I can't really use like electronic gadgets…because I don't, I never had the opportunity to have one …*

P1&6*: Language barrier among students mostly … it's you have to communicate with each other with the same language and sometimes you find it difficult in terms of expressing yourself what you want to say…*

Students from Institution 2 also suggested several improvements, including additional or more frequent classes, access to past exam papers, site visits, and increased frequency of assessments. Additionally, some students advocated the provision of hardcopy study materials such as textbooks to enhance their learning experience. Students recommended enhancing communication between the quantity surveying and construction management departments regarding workload and scheduling to ensure better coordination.

P7: *… I wouldn't mind additional Quantities classes because I feel like the whole once-a-week cycle can really put you off …*

P9: *… they don't really communicate with one another, so then we feel like it overfloods your work, coming from both sides … they don't communicate …*

P2: *… Site visit and also regular testing …*

P5: *… But I feel like there should be more clarity and like, like she said, a textbook would be really helpful, a textbook in this, in Quantity Surveying. The slides helps us and also the videos but a textbook would really help …*

Students from the second institution responded that there was room for improvement specifically related to the current teaching approach with the following comments:

P2: *… The reason why I'm saying that is that when the going gets hard, we study to pass tests and that's going to be a problem when we finish our degree and we have to*

> *work in the field, So I think, I think the, the way that we are being taught, like the lecture slides and everything, it's just, it's not really effective in terms of learning. It's going to force us to go to that position where we have to cram to pass the test …*

In response to the question students from the third institution mentioned that they were concerned about the end-of-year examination.

> P3: *… But ja, then you have to start, starting from February to October, which is going to be a very big problem. So, it's not about ma'am, it's just having to have that much information, as much as we do know, but having to write all of that in one exam will be a challenge …*

Further, one student raised concern about the consistency of teaching by saying:

> P3: *… too much of a good thing is a bad thing, because now, we'll, we'll become so accustomed to the teaching style, come next year, when we don't have her, all of a sudden it's an issue …*

Among the key challenges identified through the data collected from the focus-group discussions are the following:

- Complexity of theory and fast pace of instruction from the lecturer.
- Difficulty and challenge due to lack of prior knowledge and introduction of new concepts.
- Struggle with understanding 3D and 2D concepts and visualization of drawings.
- Large class sizes leading to delayed addressing of questions.
- Inadequate study materials and unfamiliarity with technology.
- Language barriers among students affecting communication.

During focus-group discussions, students suggested several improvements for the building measurement module, including incorporating site visits into teaching, increasing assessment frequency, offering hardcopy worksheets and examples, providing more feedback on submitted work, dividing classes into smaller groups for personalized learning, utilizing videos and 3D models for content delivery, conducting tutorial sessions with support from senior students or tutors, scheduling additional or more frequent classes, granting access to past exam papers, ensuring provision of textbooks in Quantity Surveying, and enhancing communication between departments regarding workload and scheduling.

The critical data extracted from the focus-group discussions provide valuable insights into key learning and teaching aspects within the building measurement module. It encompasses information regarding students' motivations for enrolling in the quantity surveying programme and their perceived preparedness levels upon entering higher education, which align with findings from the baseline survey (section 5.2.4). Furthermore, it shed light on students' current experiences within the building measurement module, offering insights into teaching approaches and their effectiveness. Additionally, the data reveal essential challenges first-year students face in the module.

In Chapter 1 (section 1.3) and Chapter 2 (section 2.8.1) of this study, a range of learning and teaching challenges in the building measurement module are discussed at national and international level. Some of these challenges, as identified in focus-group discussions, are consistent with those reported by various authors. However, it is important to clarify that these challenges are not exclusively based on the experiences of first-year students in the building measurement module. Rather, they stem from broader observations involving students enrolled in the quantity surveying programme, reporting on their experiences with the building measurement module or addressing challenges within construction education more broadly.

The most similarities are those to pedagogical challenges investigated by Ostrowski (2010) in an international context in the building measurement module, not specifically on first-year level, though. These include students' struggles with the procedural knowledge involved in measurement, difficulties with numerical calculations required for measurements, inadequate understanding of construction or building technology, challenges with ruling in taking-off sheets, and issues arising from lecturers' pacing. Additionally, alignment is observed with the challenges identified by Tunji et al. (2016) and Gurmu and Mahmood (2020), as presented in Chapter 1 (section 1.3).

However, previous research has not addressed the challenges first-year students face in the building measurement module resulting from their underpreparedness and lack of prior knowledge in the subject matter. While various studies in higher education research discuss the experiences of first-year students and their underpreparedness upon entering higher education institutions, this phenomenon is widely acknowledged globally. Moreover, research studies, as presented in Chapter 2 (section 2.7), have established numerous challenges in construction education and quantity surveying education, particularly within the building measurement module. Despite this, no research specifically examines the challenges encountered by underprepared first-year students in the building measurement module. Therefore, the findings of this research contribute to this gap in knowledge. It is evident from the challenges identified through the data obtained from student focus groups that some challenges differ from those already established in previous research studies.

Notably, there appears to be a knowledge gap in the literature concerning these challenges among first-year students in the building measurement module at South African universities, specifically. These data are pivotal to the study's objectives, particularly in determining the challenges encountered by first-year students in the module, which was the primary aim of the initial methodology.

In the following section, I present the data gathered from interviews conducted with lecturers.

5.4 INTERVIEW RESULTS

This section of the chapter presents data gathered from semi-structured interviews conducted with four first-year building measurement module lecturers at four institutions, as presented in Chapter 4. The lecturers were invited to participate in these interviews with the primary objective of exploring their experiences and challenges in the learning and teaching of the building measurement modules at the first-year level. The interviews covered 17 questions designed to address the research objectives. The discussions were recorded and transcribed, and the subsequent sections present the data collected. Information was organized thematically, establishing four key themes derived from the interview data: 1) teaching experience, 2) first-year student experience, 3) current teaching approaches, and 4) challenges. The themes that emerged from the data were identified through a structured analysis process. The qualitative data from the interviews were manually grouped into themes by identifying recurring patterns. This approach provided a systematic way of organizing and interpreting the data.

5.4.1 Theme 1: Teaching Experience

In the first theme, lecturers' teaching experience and qualifications were discussed. The lecturer at the first institution indicated that she has been teaching the building measurement module for 12 years, she has a master's degree, and is a professional quantity surveyor. She believes there is merit in having practice experience, as it gives a different dimension to teaching, especially in the building measurement module. The lecturer at Institution 2 has taught the building measurement module for three years. She is a candidate quantity surveyor with five years of industry experience and a master's degree. She also believes that industry experience is necessary to teach this module. The lecturer at Institution 4 is a professional quantity surveyor with a doctoral degree, and it is her first year teaching the building measurement module to first-year students. She has four years of industry experience. She also agrees on the importance of industry experience when teaching the building measurement module. The lecturer at Institution 5 indicated he has a doctoral degree with five years of industry experience and 11 years of experience teaching the building measurement module. He is also in agreement with the other lecturers about the importance of practice experience in teaching the building measurement module. Based on the data, there is unanimous consensus among all first-year building measurement module lecturers at the four participating institutions regarding the significance and importance of industry experience in teaching this module. Theme 2 provides insights into the lecturers' experiences while teaching the building measurement module to first-year students in their classes. Once again data are presented per insitution.

5.4.2 Theme 2: Experience of First-year students

In the second theme, focusing on the lecturer's experiences, they were asked about their observations and opinions regarding student preparedness and readiness in their classes. The lecturer of Institution 1 asserted that first-year students lack critical thinking skills and demonstrate an overdependence on technology. She highlighted that students face challenges linking technical modules that inform the quantities module, such as the building technology modules. Moreover, she emphasized that students often lack a tangible understanding of buildings and building materials some of them also struggle with visualization of 2D and 3D images. According to the lecturer, first-year students in her class arrive at university ill-prepared, and show a noticeable decline in numerical and literacy skills annually. She observed that nothing at the school level adequately prepares students for the building measurement module. Specifically, she noted,

> *from a quantity surveying perspective or Quantities perspective at least, I accept that there's nothing at school level that prepares them.*

Furthermore, she confirmed the presence of senior students in her class, some of whom had transferred from other departments such as engineering. Although senior and mature students are noticeable in class, she did not have evidence to show their performance is better than first-year students. The lecturer believed that first-year students are coached rather than taught at high school, contributing to the articulation gap from matriculation into the first year of higher education. She also noted first-year students' problem-solving, critical thinking and analytical skills deficiencies.

In response to how she deals with underprepared students in her class, she explained that she is patient with the first-year students. She answers their questions and ensures they understand the work; she also mentioned the formalized tutor system that is in place for first-year students in their department, which is mainly presented by cum laude senior students. Despite the big class size and student disparity, she accommodates every student. She also encourages participation and active engagement from students during class. She described how she tries to support her first-year students,

> *… because it is such a large group, there is also a very big disparity within the group … Then I say, we don't have to go through this stuff with the speed of lightning, you ask until you are comfortable and I will explain and explain and explain, and we have a, a good-developed tutor system. We have, currently we have five tutors in the department, obviously those are all cum laude students from the department …*

When the lecturer of Institution 2 responded to the question about her experience of first-year students in her class, she expressed concern about the prevalent language barrier among students, elaborating on this issue and remarked something significant,

> *… But when you start saying something in their language, they'd be like, is that what that is, and I'm like, yes, you use it every day at home and then, we wait in class to hear the student ask the question in Xhosa and it's difficult, you know, in English. And then I would have to, you know, like translate what the student said and then everyone , you know, jump into the boat and start answering. But I think it, it has played a huge role in terms of understanding because remember, construction has their own terminology. I think at the same time as well, it, it's not the determining factor because you can explain something to a student in their own language but if their thinking capability, in terms of how or how quick they can grasp something, then that's what determines that …*

Another intriguing observation she made was the existence of friction between quantity surveying and construction management students in her class, primarily attributed to attitude issues. She also expressed that students struggle to establish meaningful connections between modules supporting the building measurement module such as construction drawings or building technology modules. She reported that first-year students are not prepared for university; she also noted a heavy reliance on lecturers' support and apparent lack of curiosity among them. She further emphasized that students complain quite often and display an entitlement mentality. She noted,

> *… first-years are not ready for the university environment … they are always complaining…that entitlement mentality that I'm supposed to get something …*

Upcraft et al. (2005) refer to this entitlement mentality of first-year students. The expectations regarding activities within college, coupled with the offerings from faculty members and educational institutions, may lead to a significant mismatch of considerable proportions. Expectations act as a lens through which students evaluate unfolding events against their anticipated outcomes, determining whether certain activities are appropriate, meaningful, relevant, and worthy of their time. Hence, students' expectations shape their behaviour, consequently influencing their academic performance and social adaptation to college life.

Furthermore, the lecturer from the second institution noted the presence of senior students in her class who appeared more mature and demonstrated better performance compared to first-year students. She noted,

> *... I've got a few, but you find that with them, they're more mature, they actually grasp everything quickly, they're able to ask questions ...*

She also acknowledged experiencing an articulation gap among her first-year students. She schedule extra theory classes to accommodate first-year students and help them to understand, she mentioned that if there is a firm foundation in the first semester, the second semester becomes easier.

The lecturer of the fourth institution also noted a struggle among students to comprehend 2D and 3D images and highlighted the difficulty in connecting different modules, which is similar to the lecturer's experience at Institution 1. Despite having a drawing module to facilitate understanding in the building measurement module, students often fail to make these connections. She remarked,

> *... It's almost, it's almost like we need to force the link, like this is how it is, they link with one another because they don't make the link themselves.*

She reported observing a decline in the quality of the basic education system and expressed concerns about the overall underpreparedness of first-year students entering higher education. Furthermore, she noted the absence of fundamental education as a significant gap that is difficult to bridge. She also reported that senior students demonstrate greater maturity and perform better than their counterparts fresh out of school. Additionally, senior students at this institution appear more dedicated to their studies. She mentioned that

> *there are always some senior students. They seem to be wiser. I think like they've learnt some life lessons and they are there to learn. They're interested, they want to be there, they are a lot more engaged, they actually often do better than the, the others ...*

She mentioned that the average student is struggling, particularly with basic concepts, and expressed that the basic schooling system is failing. The lecturer also reported that she schedules extra lectures on problem areas and makes a point to adjust her teaching approach every year and she monitors her students throughout the semester on problem areas. She also makes videos on specific concepts available for students to engage with. She explained her efforts as,

> *... I have been adjusting it every year and especially if I, through, throughout the semester I pick up specific things that is recurring as a, as a theme of their struggling with, then I will, whatever that was they were struggling with, I would then ... I would get photos because sometimes it's a simple photo that actually solves the problem. Specifically for concepts that is difficult, I'll make little videos that goes to that concept.*

The lecturer of the fifth institution mentioned that first-year students find the building measurement module a challenge, particularly struggling with the terminology, formulas, and measurement rules. Additionally, he expressed the view that students tend to be spoon-fed at school and he mentioned the presence of an articulation gap when students initially enter his module. He commented

> *that there is that gap in articulation, and unfortunately, at varsity, they don't have enough time, to adapt to all of this.*

Furthermore, he reported that senior students generally perform better, especially those from an extended programme.

Key concepts highlighted in Theme 2 encompass a variety of concerns and insights shared by the lecturers across the institutions regarding their experiences of first-year students. These include concerns surrounding the preparedness and readiness of first-year students in their classes. Language barriers among students were acknowledged as impacting communication and understanding within the classroom environment. Additionally, observations were made regarding tensions between quantity surveying and construction management students, alongside the recognition of an entitlement mentality among first-year students. Notably, the presence of senior students demonstrating superior performance and maturity compared to their first-year counterparts was a recurring theme.

Furthermore, challenges in comprehending 2D and 3D images, as well as connecting different modules, were commonly noted by lecturers. Concerns were also raised regarding the decreasing quality of basic education and the overall underpreparedness of first-year students entering higher education. In response to these challenges, lecturers described efforts to adapt teaching approaches, provide additional support, and closely monitor student progress throughout the semester. From these discussions, it is also clear that all the lecturers experience an articulation gap between matric and the first year with an emphasis on the lack of critical thinking, numerical and literacy skills among first-year students.

Notably, very limited research literature is available on lecturers' experiences with first-year students in the building measurement module. Due to this scarcity of research on first-year experiences in this specific module, it can be inferred that some of the challenges reported here are documented for the first time. While Haupt (2009) notes underpreparedness among first-year students entering construction education, there has been little investigation into their performance and impact, specifically within the building measurement module. As previously mentioned, various challenges have been observed in construction education, including some specific to the building measurement module. Yet, the findings from this study reveal new evidence concerning lecturers' experiences with underprepared first-year students in this particular module.

The subsequent section presents data categorized under the third theme, teaching approach, derived from interviews conducted with the lecturers.

5.4.3 Theme 3: Teaching Approach

Lecturers at the various institutions were asked about their teaching approach within the building measurement module. The lecturer from Institution 1 mentioned she has a very simplistic approach to ensure students understand the work. She emphasized the importance of learning her students' names to foster engagement and commitment in class. Encouraging active participation, she facilitates interaction through practical group examples, providing feedback and support as students work. She discusses an example and then assigns a similar task for students to engage with collectively. Additionally, the lecturer maintains a collection of drawing examples, regularly revising and rotating them. She explained her approach as follows:

> *So, I have a few examples, there are about fifteen of them in my drawer, I try to put the same kind of elements in, in all the drawings, you know, I try to pick up on the trends, you know, you can only be guided by your class, but in the end, you have a responsibility to go through the curriculum.*

She remains flexible in her teaching approach and is willing to adjust if students encounter specific challenges, although discerning whether these issues are group-wide or individual can be challenging.

The lecturer from Institution 2 structures her classes with one session dedicated to theory per week, followed by a separate question-and-answer session on the theory covered. She strives to make her classes as practical as possible by drawing connections between the module content and students' surroundings. She explained,

> *… So, I've tried to make it as practical as possible by telling them, you live in a house and try and dissect that house into the elements that are in the standard system and see if you won't understand what we're talking about ...*

Utilizing a module guide, she distributes hard copies of measurement examples for in-class discussion, supplementing these with additional examples for students' reference. Additionally, the lecturer regularly adjusts her teaching approach, engaging in mid-year reflection to identify and address any areas requiring corrective action in her teaching methods.

The lecturer from the fourth institution has established a team of tutors to aid students with questions or concerns related to the building measurement module. She allocates two weekly timeslots, one dedicated to theory and the other to practical aspects. Each concept receives an hour of attention, with a preference for discussing theoretical aspects before delving into practical applications. She methodically works through examples, providing step-by-step guidance before assigning tutorials or assignments for independent measurement practice. Additionally, she creates concise videos and captures photos of key concepts. Moreover, the lecturer regularly adapts her teaching approach throughout the semester and makes adjustments annually, particularly if she identifies issues or challenges arising during the course of the year or semester. She mentioned that

> *I have been adjusting it every year and especially if I, through, throughout the semester I pick up specific things that is recurring.*

The lecturer from Institution 5, follows a constructivist teaching approach as it is vital for students to create their knowledge. He believed that

> *... it's important for them to really, you know, create knowledge for themselves. And you know, what I do is, in class, when I give them the building plans, I ask them to read, interpret and analyse the drawing and create what we call a measuring list. Now, as I'm saying, I'm using constructivism because when they're doing that, they are creating knowledge themselves. So, constructivism, I think is, it's the best in, in this regard.*

His approach includes the handing out drawings or building plans and encouraging them to create a measuring list based on the information presented in the drawings. This approach allows students to independently construct their understanding of the material. Unlike some of his counterparts, the lecturer from the fifth institution does not regularly adjust his teaching approach. Instead, his teaching methods are informed by his practical experience, suggesting a consistency in his instructional approach over time.

Lecturers were also asked if they engage with a baseline survey at the beginning of the year to determine students' knowledge. The lecturer from the first institution indicated that she does not do a formal or official baseline knowledge assessment among her first-year students. The lecturer from Institution 2 indicated that she does informal baseline assessments regularly to identify hindrances to students' learning. The lecturer at the fourth institution also does not engage in any baseline evaluations, she assumes that students know certain things. The lecturer at Institution 5 does not apply baseline in his first-year module. Of the four institutions, only one does baseline assessments. Thus, it is not common practice among lecturers of the building measurement on the first-year level to engage with baseline knowledge determination or assessment. Baseline assessments can be useful and can assist the lecturer in their teaching approach. It is, however, important to note that some lecturers assume prior knowledge.

From these data, Theme 3, it is evident that 1) lecturers prioritize practical applications of module content, drawing connections between theoretical concepts and real-world scenarios to enhance student understanding; 2) some lecturers emphasize constructivism, encouraging students to actively engage in creating their knowledge through hands-on activities and independent exploration; 3) lecturers establish support structures such as tutor teams to aid students with questions or concerns related to the module, providing additional resources and guidance as needed and 4) while some lecturers regularly adapt their teaching approaches based on observed challenges, others maintain a consistent instructional approach informed by practical experience. It is also clear that lecturers at the various institutions invest a lot of time in their students. Lecturers encourage active engagement and student participation during their lectures.

In Chapter 2 (section 2.8), the teaching of quantity surveying, particularly in the building measurement module, is discussed. Several authors advocate adjusting the teaching approach in this module to better support students. Suggestions include implementing more active engagement, incorporating real-life examples, organizing site visits, and adopting a learner-centred approach, which implies a constructivist teaching approach (Chan et al., 2002;

Mohamed et al., 2018; Lueng & Chen, 2008). From the findings of the lecturer interviews, it is apparent that in their current teaching approach to the building measurement module at the first-year level, they do incorporate certain elements of the constructivist teaching approach. These elements include integrating real-world scenarios, facilitating practical applications, promoting active engagement and fostering groupwork. However, while these lecturers do not follow a traditional teaching approach, there is very little evidence of a structured or intentional approach to implementing non-traditional learning and teaching approaches in the building measurement module.

In the next section, data from the last theme, Challenges, are presented.

5.4.4 Theme 4: Challenges

The insights derived from the data in Theme 4 play a pivotal role in this study, serving as the focal point for addressing the research problem. Given the dearth of literature concerning the challenges encountered by first-year students and lecturers within the context of the building measurement module in South Africa, this methodology's primary objective is to investigate and identify these challenges.

According to the lecturer from Institution 1, the biggest challenge is the large class; it makes engagement and interaction challenging. The other frustration she experiences is students not attending their classes and then wanting personal attention to catch up on their missed work. She mentioned,

> *.. My biggest struggle is actually the large class and, what does frustrate me is, students that don't come to class and then, they want personal attention, you know, at, at some crunch time or whatever …*

She emphasized the importance of the Building Technology, Building Services and Building Science modules, consistently referencing and cross-referencing their content as these modules run in sync with each other and support the building measurement module. Despite her efforts, students struggle to connect meaningfully between these modules. Students tend to put these modules in little silos, and she iterates that the quantities module cannot stand on its own. She elaborated,

> *… I enforce that by repeating it almost literally in every lecture that I … especially when we get onto the measurement rules, for instance, I would say that, look in the building technology class you are doing, because to illustrate the measurement rules is*

almost like a Building Technology lecture, because you got to explain to the students where, you know, what, what is this that we're measuring and why do we put certain things in the description and so on, you know. I will always cross-reference because our curriculum is, is designed in such a way that what happens in the Building Technology class is just a little bit ahead of when the same things are measured …

Echoing this sentiment, the lecturer at the second institution agreed and pointed out that students face challenges in linking modules with the building measurement module, such as the Materials and Methods module, which will significantly assist in their understanding of the building measurement module. Furthermore, she mentioned that students do not understand what they are measuring; they struggle with 2D and 3D visualisation, which contributes to the lack of understanding of measurable items of a structure. In her class, she also experiences the influence of the language barrier among students. She mentioned that the lack of prior knowledge is sometimes frustrating for students. She also mentioned the challenge of presenting the module. With the available technology, where one might need multiple screens to display the drawings and the measurements, and sometimes students also struggle to adapt to the use of technology.

The lecturer from institution four agreed with the lecturer from the first institution and mentioned that her biggest challenge is the large class and the wide range of preparedness levels among the students, and the lack of prior knowledge and experience, which she refers to as common knowledge or knowledge about general things. Similar to the lecturers of Institutions 1 and 2, the lecturer at Institution 4 agreed and suggested students should be forced to establish connections between modules, specifically modules such as Drawings and the Building Technology modules. She explained,

… it's almost like we need to force the link, like this is how it is, they link with one another because they don't make the link themselves …

Institution 5's lecturer reported that his biggest challenge is the lack of students' ability to read and interpret construction drawings and an understanding of the rules of measurement and the Standard System of Measuring Building Work document. Being proactive, the lecturer at Institution 5 personally undertakes teaching students about drawings and building technology in his building measurement module as he strongly believes that students cannot measure what they cannot see. He explained,

… I find myself having to teach technology first before you can teach quantification because you need to analyse the, the drawings before you can start measuring. I always say to my students, you cannot measure what you cannot see …

Lecturers across institutions highlight the difficulty of engaging with large classes, the frustration of students missing classes, and then seeking individual attention to catch up. There is a recurring theme of students struggling to connect various modules, such as Building Technology, Building Services, and Building Science, with the building measurement module, despite efforts from lecturers to emphasize the interconnectedness of these modules, students often struggle to integrate their learning. Students encounter challenges in visualizing and understanding 2D and 3D representations of structures and interpreting construction drawings and measurement rules, this lack of visualization and understanding poses significant obstacles to learning within the building measurement module. Lecturers also mention the influence of language barriers among students, particularly in understanding technical terminology. One lecturer experiences challenges in presenting the module content using available technology, especially when multiple screens are required to display drawings and measurements effectively. Lecturers expressed concerns about the wide range of preparedness levels among students entering the building measurement module which includes a lack of prior knowledge and experience, particularly in general knowledge.

Table 5.10 below summarises the data collected from focus-group discussions with first-year students and semi-structured interviews with lecturers. From this information, it becomes apparent that both students and lecturers highlighted several challenges. It is intriguing to note that there are similar challenges reported between them.

Table 5.10: Key Challenges Identified

Focus-Group Discussion (students)	Semi-Structured Interviews (lecturers)
Gap and a big jump from school to university.	Confirmation of articulation gap among first-year students entering higher education for the first time.
Students feel underprepared; they feel they were babied at school, and the school system is letting them down, now they are dependent on lecturers	Students want to be spoon-fed and babied; they are entitled and not curious.
	The basic school system is failing the students, quality of schooling education is seemingly getting worse every year.
The use of technology is foreign to some students who have not had access to it before.	The use and availability of appropriate technology to lecture is a problem.

Students struggle to make connections between modules and realise the interconnection of the curriculum.	Students struggle to make meaningful connections with other modules such as Building Technology, Drawings, etc.
Lack of site visits.	
Students would like peer interaction in the tutorial classes.	
Too many students in the class, and thus questions don not get answered and students are afraid to ask questions in this large class.	Large classes are problematic and make active engagement a challenge.
Some students are afraid to ask questions in class due to the large class and many students.	Friction among quantity surveying and construction management students were observed, mainly differences in attitude towards the building measurement module. Construction Management students do not feel the need for this module.
The workload of the module is too much.	Lecturers experience a big disparity in the preparedness and prior knowledge level of students in their class.
The pace of instruction from the lecturer seems too fast.	
Social, academic and economic challenges like managing a budget, having a lot of responsibilities, and feeling alone and far away from family and friends.	
Terminology of the module is hard.	Students struggle with terminology and formulas and measurement rules.
The building measurement module is a challenge; theory and new concepts are hard.	Students cannot interpret or read construction drawings.
	Students do not understand what they are measuring.
Students lack prior knowledge and find it frustrating.	Students are ill-prepared, underprepared and have no or limited prior knowledge.
The lecturer assumes prior knowledge and this also frustrates the students.	Lecturers assume prior knowledge and general knowledge of certain things from students.

Students cannot visualise 2D and 3D images and drawings.	Students struggle to visualise 2D and 3D images.
Time management skills and scheduling are a problem for students.	Students do not have a feeling (aptitude) for buildings or the (construction/built) environment, which hinders their understanding of certain concepts related to the built environment.
Different languages between students seem to be a problem.	Language barrier among students and between the lecturer and the students. Sometimes students understand concepts better and faster when explained to them in their first language.
Perceived preparedness and expectations. Students feel prepared, but when they enter higher education, they realise their expectations are unrealistic and they are not prepared well enough. Students tend to overestimate their preparedness.	Lack of critical thinking skills and curiosity.

When comparing these findings with the existing literature, several similarities emerge. However, the contexts differ due to the challenges being addressed in either the broader building measurement module, not exclusive to first-year students, or specific to first-year students in general, rather than specifically within the quantity surveying programme. As illustrated in Chapter 1, Figure 1.1, the depicted knowledge gap emphasizes this contrast. Similar challenges include the heavy workload within the building measurement module, the rapid pace of instruction, student struggles with module content, difficulties with measurement rules and calculations, limited comprehension of construction technology, and issues with time management skills (Ostrowski, 2010; Tunji-Olayeni et al., 2016; Gurmu & Mahmood, 2020; McDonnell, 2010; Lee 2013; Tunji-Olayeni et al., 2021; Gurmu et al., 2021). In contrast to these common challenges, no evidence could be found to support particular issues identified in previous studies, such as difficulties in managing group assignments, teaching styles that hinder comprehension, and lack of exposure to software and non-interactive lectures (Ostrowski, 2010; Tunji-Olayeni et al., 2016; Gurmu & Mahmood, 2020; McDonnel, 2010; Lee 2013; Tunji-Olayeni et al., 2021; Gurmu et al., 2021). This disparity might be attributed to the broader focus of these studies, which did not specifically target first-year students.

Following the thorough dissection, analysis, interpretation and presentation of data collected from the first methodology in the preceding section, the subsequent section organizes these data into four meta-themes.

5.5 THEMES EMERGING FROM THE DATASETS

When taking a step back to look at data obtained from the baseline survey, from the focus-group discussions among first-year students in the building measurement module, as well as the semi-structured interviews with the lecturers of this module, meta-themes were established. Creating themes from the qualitative involves a systematic analysis process. Themes serve as overarching concepts or ideas that capture the essence of the data. I analysed the data to identify recurring patterns, topics or concepts that emerge from the different datasets, allowing for data triangulation. Before diving into analysis, I familiarized myself with the data by reading and re-reading it; this process helped me to understand the context, nuances, and overall content. I started by coding the data and systematically labelling segments with descriptive codes. After the initial coding phase, I identified patterns or connections between different codes that might involve recognizing similarities or differences and noting recurring themes or topics. Drawing from the identified patterns, I generated themes that are broader than individual codes and represented the main topics or issues that emerge from the datasets.

The four key meta-themes that emerged from the data gathered in the first methodology included pedagogy, environment, content and prior knowledge and skill. Each of these meta-themes are discussed in the next subsections.

5.5.1 Pedagogy

The first meta-theme identified is that of pedagogy. Methodology One's findings indicate a clear awareness among both students and lecturers of an articulation gap within the first-year cohort entering higher education. Students noted a significant gap or leap between matriculation and the first year of higher education. Another noteworthy discovery was the shared belief among students and lecturers that students are spoon-fed during their school years, leading to dependency on teachers. This dependence persists in higher education, with students expecting to be spoon-fed by their lecturers. All participants unanimously agreed that the basic schooling system fails to adequately prepare students for higher education, contributing to this dependency, which worsens yearly. Another significant finding, particularly emphasized by lecturers, is that students struggle to establish meaningful connections between their modules, particularly those supporting the building measurement module, such as Building Science, Building Technology, Materials and Methods, etc. The use of technology among students and lecturers is also problematic to a certain extent. Site visits also seem to require improvement.

5.5.2 Environment

The second prominent meta-theme derived from the data collected through the first methodology is that of the learning environment, encompassing various issues and challenges. Both students and lecturers reported that classes are extensive, leading to difficulties in adequately addressing questions or concerns. Students expressed concerns about the high workload and the fast pace of lectures, while some also faced interpersonal friction among classmates and additional social and economic challenges. Lecturers highlighted the significant disparities among students, which can challenge teaching approaches. Tutorial classes and the set-up and presentation thereof enjoyed much attention in the discussions among the students and lecturers.

5.5.3 Content

Thirdly, the content meta-theme was established, encompassing challenges related to the building measurement module's content. Students find the content of this module challenging, especially the terminology, theory, formulas, and the application of measurement rules. Additionally, students struggle with understanding the new concepts introduced in this module. Lecturers believe that students cannot read or interpret construction drawings correctly and do not understand what they are measuring.

5.5.4 Prior Knowledge and Skill

The final meta-theme, concerning prior knowledge and skills, addresses students' lack of preparedness upon entering higher education. Lecturers' expectation of students possessing prior knowledge proves problematic, as mentioned by both students and lecturers. Despite students' confidence in their preparedness for higher education, they often realize their inadequacies upon enrolment. Students often exhibit a high level of perceived preparedness, and upon entry into higher education, they are caught off guard and are not prepared. Other challenges include students' inability to visualize 2D and 3D images, understanding of buildings and the built environment, and deficient time management skills. Language barriers also present a significant hurdle. Lecturers further noted a deficiency in students' critical thinking abilities and a lack of curiosity in learning.

5.6 CHAPTER SUMMARY

Data were gathered from three distinct data points in the first methodology. As explained in Chapter 4, this study employed two distinct, yet complementary methodologies due to the absence of contextual knowledge and understanding regarding the pedagogical challenges encountered by first-year students and lecturers in the building measurement module at South African universities. Upon identifying and delineating these challenges, the second methodology, employing a case-study design, investigated the implementation of constructivism as a teaching approach, with specific reference to Vygotsky's theory of sociocultural development and the application of key concepts of this theory, such as scaffolding, zone of proximal development and the more knowledgeable other.

The baseline survey provided vital information about the demographics and student profile, determining prior knowledge, experience and exposure to key components of the quantity surveying profession at large and the building measurement module. This baseline survey confirms that students feel underprepared, and have limited prior knowledge, experience and exposure, except for a few individual senior students. Findings from the baseline survey speak mainly to the first sub-research question on preparedness. Key findings and deductions from the surveys include that the majority of the students in the building measurement modules are between 18 and 19 years old, and there are, to some extent, certain misconceptions about the profession of quantity surveying. Students study quantity surveying mainly because of family associations; they have limited prior knowledge, experience and exposure to various related elements to the building measurement module, such as the construction industry and quantity surveying profession. However, knowledge and experience of construction drawings and scale are better. Students did not exhibit a high level of general knowledge about quantity surveying. There are some discrepancies between the three institutions regarding knowledge of certain measurement module elements, as depicted in Table 5.6.

From the focus-group discussions, it seems students decided to study quantity surveying based on family association; these data correlate with data from the baseline survey. Students feel underprepared when they enter university; they believe that school does not prepare them enough for the transition into higher education; these data correlate with that of the survey. The focus-group data also revealed various challenges experienced among first-year students, which, in addition to their underpreparedness, creates a challenging first year. Across all three institutions, students find the building measurement model enjoyable, and they understand the purpose and importance of this module; however, this module remains difficult, since students have limited prior knowledge and are underprepared.

In sum, from the interviews with the lecturers, lecturers were in agreement about the importance of industry experience when presenting the building measurement module. The lecturers indicated they experienced various challenges in teaching the building measurement module. Senior students are noticeable in class and perform better than their younger counterparts. The lecturers among the first-year students experience a clear articulation gap; despite the various challenges, the lecturers of this module are passionate and committed to their teaching.

This chapter presented the results and findings of the initial methodology employed – the convergent mixed method, employing a multi-method research approach. Given the absence of contextual knowledge and understanding regarding pedagogical challenges faced by first-year students in the building measurement module at South African universities, it was imperative to investigate several critical issues. These included assessing the current preparedness levels of first-year students entering higher education, identifying challenges experienced within the building measurement module by students and lecturers, and evaluating the effectiveness of current teaching approaches. Such insights are pivotal for proposing and testing potential solutions to these challenges, notably the application of Vygotsky's theory of sociocultural development, focusing on the concept of scaffolding and if all challenges were known and identified, only the case study had been implemented, but unfortunately, minimal data were available on this specific matter. Valuable data were gathered using a baseline survey and focus-group discussions among first-year students and semi-structured interviews with lecturers. This vital information will inform the teaching interventions applied in the case-study design, which will be presented in Chapter 6.

The meta-themes identified from the initial methodology's three distinct data sources served as crucial guides for informing teaching interventions in the subsequent case-study design. Given the limited contextual understanding of pedagogical challenges encountered by first-year students in the building measurement module, these meta-themes are invaluable. This research aimed to address these challenges within the module at first-year level. The emergence of various challenges from the collected data emphasizes the importance of utilizing these data to implement teaching interventions in the case-study design. Specifically, the application of Vygotsky’s sociocultural development theory, particularly the concept of scaffolding, will be assessed to support first-year students and enhance their learning experience.

CHAPTER 6
RESULTS AND FINDINGS
METHODOLOGY TWO – CASE STUDY

6.1 INTRODUCTION

The data obtained from the first methodology, as presented and discussed in Chapter 5, served as the foundation for informing the second methodology, namely the case-study design. This chapter provides an overview of the four teaching interventions (see detailed explanations in sections 6.2–6.5) implemented within the case-study design. This case study took place at one institution with 26 first-year students enrolled for the building measurement module (BMQR1504). The four teaching interventions were implemented over ten weeks in the second semester of the 2023 academic year, with two to three weeks in between the interventions. The teaching interventions were planned to fit in with the existing curriculum and only focused on adjusting the learning and teaching methods and not alter the curriculum.

In Figure 6.1, the second methodology is illustrated to remind the reader about the intricate multi-method methodology used in this study.

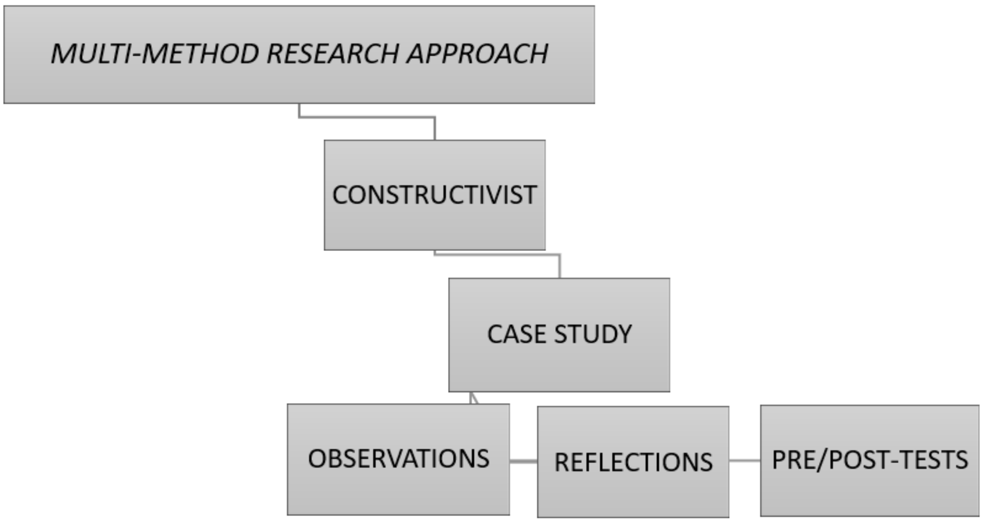


Figure 6.1: Multi-Method Research Approach: Methodology Two (Author's Own)

The purpose of employing a multi-method research approach stems from a lack of contextual knowledge and understanding of first-year pedagogy within the building measurement module at South African universities (see also Chapter 4 for a detailed discussion on the methodologies and Chapter 5 for data collected from the first methodology). The second methodology aimed to address the challenges identified in Chapter 5, drawing on Vygotsky's sociocultural development learning theory with critical elements of constructivism and scaffolding. Following the identification of the challenges as presented in Chapter 5, Table 5.8, some challenges were selected for inclusion in the case-study design, adopting a constructivist teaching approach that incorporates Vygotsky's theory of sociocultural development, including key concepts such as scaffolding, the more knowledgeable other (MKO), and the zone of proximal development (ZPD) explicitly.

Chapter 5, Table 5.8 illustrates the different challenges identified from the data collected in the initial methodology. Challenges to be addressed in the case-study design were chosen based on their relevance to the first-year building measurement module curriculum content at one of the institutions selected for the case study. Additionally, challenges were selected for implementation, considering the available resources.

Numerous issues and challenges surfaced during the data-collection phase of the initial methodology, as outlined in Chapter 5. Significant insights and data were collected regarding the challenges and experiences encountered by first-year students and lecturers in the building measurement module across different South African universities. Focusing on identified challenges, these data were organized and categorized into four overarching themes. These challenges were systematically categorized into thematic groups, culminating in identifying four overarching meta-themes: pedagogy, environment, content, and prior knowledge and skill. To address some of these challenges in the case-study design, selected thematic challenges were addressed through a series of teaching interventions grounded in a Vygotskian framework. Subsequent sections of this chapter introduce and elaborate on the four teaching interventions implemented over a ten-week period during the second semester of the 2023 academic year at a particular institution offering an accredited quantity surveying programme.

Each of the four teaching interventions is subsequently presented in a standardised format, beginning with a comprehensive overview of the teaching intervention, followed by an explanation of the teaching and scaffolding activities applied and implemented during the intervention, and concluding with an analysis of the data collected through the pre- and post-tests, participant observation, and reflections, all of which contribute to the dataset within the case study.

A final reflection segment is provided in the concluding section of this chapter. This final reflection emanates from students, shedding light on particular challenges that could not be implemented and tested practically in the teaching interventions. Nonetheless, students offered valuable insights into these aspects through the reflection.

In the next section the identified challenges to address in the teaching interventions are presented and discussed.

6.2 IDENTIFIED CHALLENGES FOR TEACHING INTERVENTIONS

In Table 5.8 of Chapter 5, four meta-themes are presented: pedagogy, environment, content, and prior knowledge and skill, revealing limited similarities between the literature and previous research on challenges in the building measurement module. This discrepancy largely stems from the lack of focus on the first-year level in existing research. As a result, there is a notable absence of contextual knowledge and literature addressing the learning and teaching challenges unique to first-year students in the building measurement module. This knowledge gap has identified several new challenges within this context, previously unmentioned in any quantity surveying educational research concerning first-year students. While challenges encountered by first-year students in higher education and students in general within the building measurement module were somewhat acknowledged, the specific challenges faced by first-year students in the building measurement module remained unexplored and undefined.

Several challenges identified in the first methodology of this study were chosen to undergo testing and application in the case-study design of Methodology Two. These challenges were addressed through diverse teaching interventions rooted in Vygotsky's sociocultural development theory, mainly focusing on concepts like scaffolding, the MKO and the ZPD. The effectiveness of these interventions was assessed to ascertain their potential for the identified issues and to explore the feasibility of establishing a facilitation framework to enhance the learning and teaching of first-year students in the building measurement module.

The following challenges were chosen for this case-study design's application. Table 6.1 illustrates the four teaching interventions related to the module content (see column two), the applicable meta-themes (see Column 3) and, in the last column, the selected challenges addressed in the four interventions.

Table 6.1: Identified Challenges to be addressed in the Case Study

Interventions	Module Content Section	Meta-Themes	Challenges Addressed in Intervention
#1	Superstructure brickwork	Pedagogy	- Students struggle to make meaningful connections with other modules such as Building Technology, Drawings, etc. Students struggle to make connections between modules and realise the interconnection of the curriculum.
		Content	- Students struggle with terminology and, formulas and measurement rules. - The building measurement module is challenging; theory and new concepts are complicated.
		Environment	- Some students are afraid to ask questions in class.
		Prior Knowledge and Skill	- Time management skills and scheduling are a problem for students. - Students are ill-prepared, underprepared and have no or limited prior knowledge. Students lack prior knowledge and find it frustrating.
			- The lecturer assumes prior knowledge and this frustrates the students. - Language barrier among students and between the lecturer and the students. Sometimes students understand concepts better and faster when explained in their first language. Different languages between students seem to be a problem.

#2	Floor finishes and applications	Environment	- Some students are afraid to ask questions in class.
		Content	- Students cannot interpret or read construction drawings - Students do not understand what they are measuring.
		Prior Knowledge and skill	- Students are ill-prepared, underprepared and have no or limited prior knowledge. Students lack prior knowledge and find it frustrating
#3	Ceiling finishes and installations	Pedagogy	- Students struggle to make meaningful connections with other modules such as Building Technology, Drawings, etc. Students struggle to make connections between modules and realise the interconnection of the curriculum.
		Environment	- Some students are afraid to ask questions in class.
#4		Prior knowledge and skill	- Students lack prior knowledge and find it frustrating. Students are ill-prepared, underprepared and have no or limited prior knowledge.
	Roof construction	Pedagogy	- Lack of site visits. - Students struggle to make connections between modules and realise the interconnection of the curriculum. Students struggle to make meaningful connections with other modules such as Building Technology, Drawings, etc.

		Environment	- Some students are afraid to ask questions in class.
		Prior knowledge and skill	- Students struggle to visualise 2D and 3D images. - Students are ill-prepared, underprepared and have no or limited prior knowledge

Table 6.1. linked with the already stipulated study's primary objective (section 1.7), which is to find solutions to the challenges encountered by first-year students and lecturers in the building measurement module. However, due to a knowledge gap in this specific domain, the exact nature and scope of these challenges were initially unknown, prompting the utilization of the first methodology to explore the challenges further. The case-study approach in the second methodology seeks to assess the effectiveness of different teaching interventions grounded in Vygotsky's theory of sociocultural development, as explained in Chapter 3, section 3.4.

In the next section, the first teaching intervention is explained, and the applied scaffolding activities are also explained and discussed. In section 6.2.3, the data collected from this teaching intervention are presented. Data from pre- and post-tests, participant observations and reflection are presented.

6.3 TEACHING INTERVENTION 1 (Superstructure Brickwork)

In the first intervention, the content topic of superstructure brickwork was discussed. The meta-themes of pedagogy, content, environment, and prior knowledge and skill are addressed. The specific challenges identified and selected from Table 5.8 are presented in Table 6.2 below. In the third and fourth columns of Table 6.2 below, the meta-themes and the challenges addressed through Intervention One are indicated and grouped. Four meta-themes are addressed with eight challenges being addressed through this intervention. In sub-section, 6.3.1, the teaching interventions are explained, and in section 6.3.2, the scaffolding activities implemented in the first intervention are presented and discussed. In section presents the data obtained from this intervention. Data from the pre- and post-tests, reflections and observations are presented and discussed.

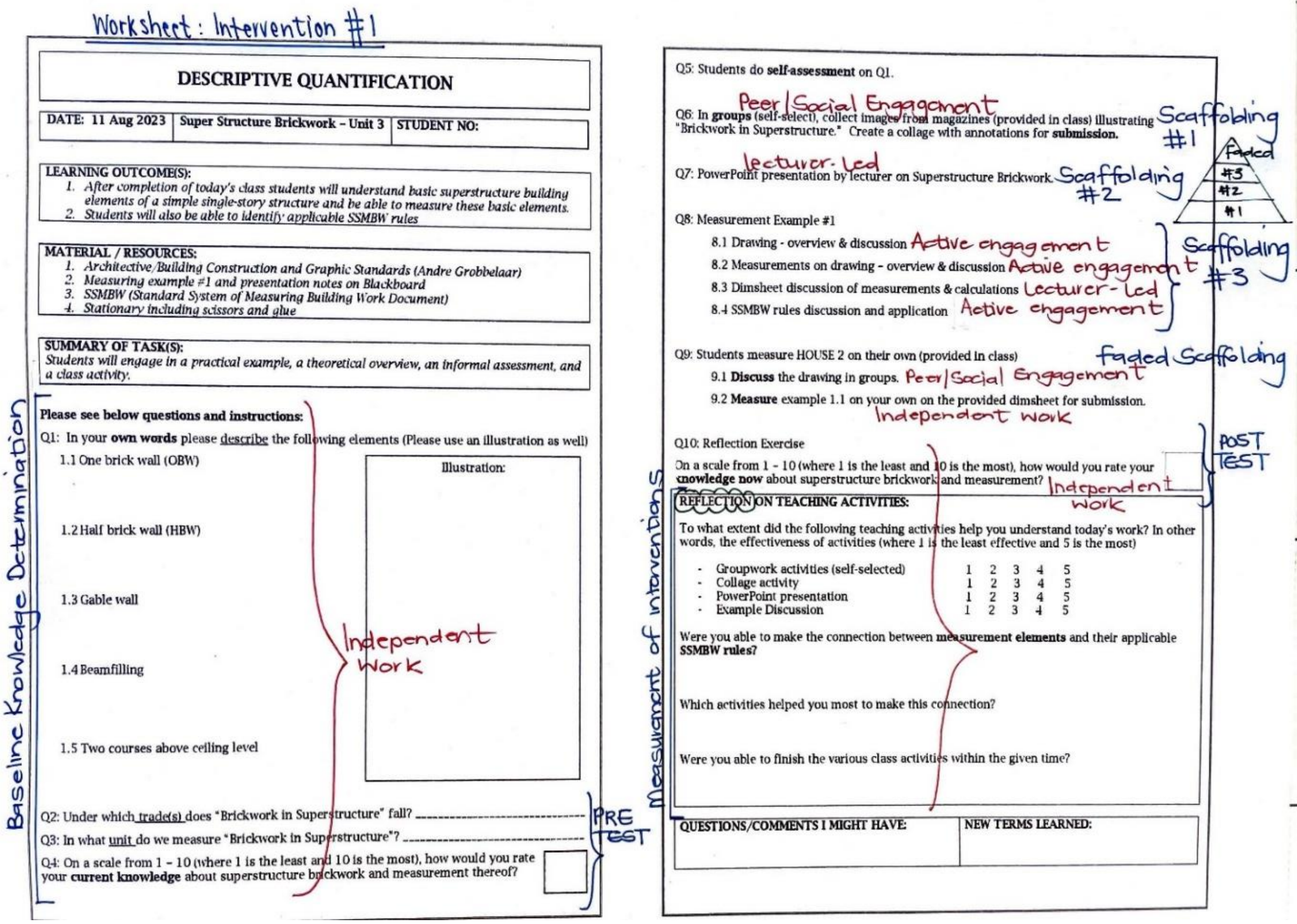
Table 6.2: Teaching Intervention 1: Meta-Themes and Challenges Addressed

Interventions	Module Content Section	Meta-Themes	Challenges Addressed in Intervention 1
#1	Superstructure Brickwork	Pedagogy	- Students struggle to make meaningful connections with other modules such as Building Technology, Drawings etc. Students struggle to make connections between modules and realise the interconnection of the curriculum.
		Content	- Students struggle with terminology and formulas and measurement rules. - The building measurement module is a challenge; theory and new concepts are hard.
		Environment	- Some students are afraid to ask questions in class.
		Prior Knowledge and skill	- Time management skills and scheduling are a problem for students. - Students are ill-prepared, underprepared and have no or limited prior knowledge. Students lack prior knowledge and find it frustrating. - The lecturer assumes prior knowledge and this frustrates the students. - Language barrier among students and between the lecturer and the students. Sometimes students understand concepts better and faster when explained to them in their first language. Different languages between students seem to be a problem.

In Table 6.2 the meta-themes of pedagogy, content, environment and prior knowledge and skill are addressed. Specific challenges are addressed thought the implementation of Vygotsky's theory of sociocultural development, with specific focus on scaffolding, MKO and ZPD.

6.3.1 Teaching Intervention 1 Explained

The first teaching intervention started with distributing a worksheet among students (depicted in Figure 6.2). (see Appendix 15) This worksheet outlined the specific learning outcomes and relevant study materials applicable to the content and was designed to assist students in following the discussion and lecture on superstructure brickwork.



Worksheet : Intervention #1

DESCRIPTIVE QUANTIFICATION

DATE: 11 Aug 2023	Super Structure Brickwork – Unit 3	STUDENT NO:

LEARNING OUTCOME(S):
1. *After completion of today's class students will understand basic superstructure building elements of a simple single-story structure and be able to measure these basic elements.*
2. *Students will also be able to identify applicable SSMBW rules*

MATERIAL / RESOURCES:
1. *Architective/Building Construction and Graphic Standards (Andre Grobbelaar)*
2. *Measuring example #1 and presentation notes on Blackboard*
3. *SSMBW (Standard System of Measuring Building Work Document)*
4. *Stationary including scissors and glue*

SUMMARY OF TASK(S):
Students will engage in a practical example, a theoretical overview, an informal assessment, and a class activity.

Baseline Knowledge Determination

Please see below questions and instructions:

Q1: In your **own words** please describe the following elements (Please use an illustration as well)

1.1 One brick wall (OBW)

1.2 Half brick wall (HBW)

1.3 Gable wall

1.4 Beamfilling

1.5 Two courses above ceiling level

Illustration:

Independent Work

Q2: Under which trade(s) does "Brickwork in Superstructure" fall? ____________

Q3: In what unit do we measure "Brickwork in Superstructure"? ____________

Q4: On a scale from 1 – 10 (where 1 is the least and 10 is the most), how would you rate your **current knowledge** about superstructure brickwork and measurement thereof?

PRE TEST

Measurement of interventions

Q5: Students do **self-assessment** on Q1.

Peer | Social Engagement

Q6: In **groups** (self-select), collect images from magazines (provided in class) illustrating "Brickwork in Superstructure." Create a collage with annotations for **submission.** Scaffolding #1

lecturer-led

Q7: PowerPoint presentation by lecturer on Superstructure Brickwork. Scaffolding #2

Faded #3 #2 #1

Q8: Measurement Example #1

8.1 Drawing - overview & discussion Active engagement

8.2 Measurements on drawing - overview & discussion Active engagement

8.3 Dimsheet discussion of measurements & calculations Lecturer-Led

8.4 SSMBW rules discussion and application Active engagement

Scaffolding #3

Q9: Students measure HOUSE 2 on their own (provided in class) Faded Scaffolding

9.1 **Discuss** the drawing in groups. Peer | Social Engagement

9.2 **Measure** example 1.1 on your own on the provided dimsheet for submission.

Independent work

Q10: Reflection Exercise

On a scale from 1 – 10 (where 1 is the least and 10 is the most), how would you rate your **knowledge now** about superstructure brickwork and measurement? Independent work

POST TEST

REFLECTION ON TEACHING ACTIVITIES:

To what extent did the following teaching activities help you understand today's work? In other words, the effectiveness of activities (where 1 is the least effective and 5 is the most)

- Groupwork activities (self-selected)	1	2	3	4	5
- Collage activity	1	2	3	4	5
- PowerPoint presentation	1	2	3	4	5
- Example Discussion	1	2	3	4	5

Were you able to make the connection between **measurement elements** and their applicable **SSMBW rules?**

Which activities helped you most to make this connection?

Were you able to finish the various class activities within the given time?

QUESTIONS/COMMENTS I MIGHT HAVE:	NEW TERMS LEARNED:

Figure 6.2: Teaching Intervention 1 Worksheet

As depicted in Figure 6.2, the initial section of the worksheet facilitated a baseline knowledge determination through independent work by the students (Q1–Q4). Determining base line knowledge can assist significantly in the teaching approach. A pre-test (Q4) was conducted to provide empirical data for evaluating the efficacy of the teaching interventions. After the lecture, students underwent the post-test (Q10), allowing for comparison to assess the effectiveness of the interventions. Furthermore, the worksheet encompassed several teaching activities, denoted as scaffolding, highlighting three layers of scaffolding (Q6–Q8), alongside a faded scaffolding activity integrated into the lecture (Q9). As indicated on Figure 6.2, students are involved in independent activities, social interactions, peer collaboration, and active engagement during the lecture, including segments of discussions and presentations led by the lecturer. This approach, emphasizing active participation and a student-centred approach, it remains consistent throughout the lecture.

The scaffolding activities are explained in detail in the next section, as this is core to the study. Scaffolding is central to Vygotsky's theory. As explained previously in Chapter 3 (section 3.4.4), scaffolding can be defined as a process of support given to a student to accomplish tasks until the student can achieve them on their own.

6.3.2 Scaffolding Activities Explained: Intervention 1

Figure 6.3 depicts the various scaffolding activities applied in the first teaching intervention. Three layers of scaffolding, in order words, three different teaching activities (Figure 6.2, Q6–Q8) are applied and a faded scaffolding activity (Q9) is also applied in the teaching intervention. As presented in Chapter 3, scaffolding involves employing various instructional techniques to lead learners towards a more profound understanding of the content.

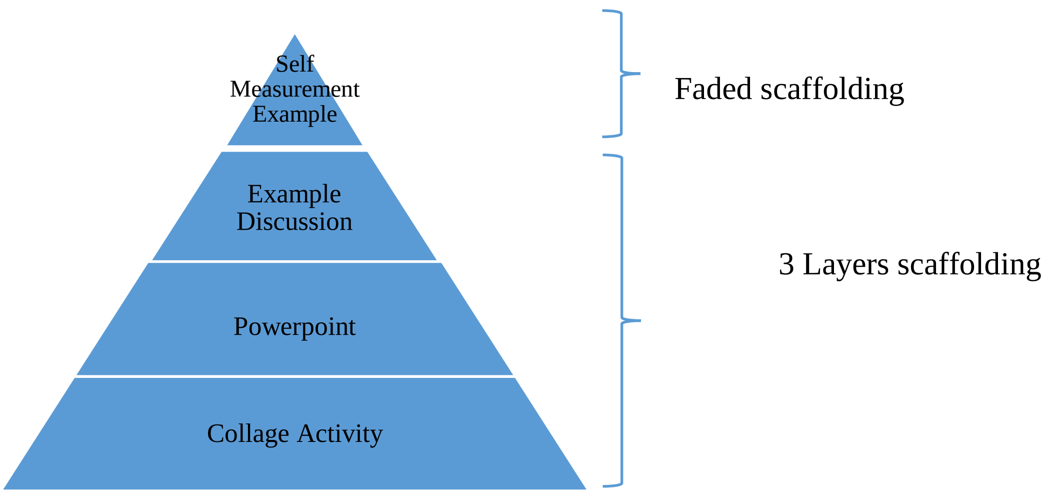


Figure 6.3: Scaffolding Activities: Intervention 1

6.3.2.1 Scaffolding 1 – Collage Activity (Peer and social engagement)

For the first scaffolding activity, a groupwork session was presented where students were tasked with creating a collage using images sourced from old magazines provided by the lecturer. Specifically, they were directed to compose a visual artwork (on A4 pages) employing the magazine clippings centred around the content topic of superstructure brickwork. The primary purpose of the first scaffolding activity was to activate students' prior knowledge related to the content topic of superstructure brickwork. For this activity, groups were allowed to form naturally based on self-selection. Peer and social interaction are significant to construct knowledge, this is the foundation of Vygotsky's theory (section 3.4), which underscores the pivotal role of social interaction in cognitive development. The overarching aim of the collage activity was to activate prior knowledge and to evoke visual representations pertinent to the content topic. After students had completed the activity, an informal feedback discussion was held on their work.

6.3.2.2 Scaffolding 2 – PowerPoint Presentation (Lecturer-led)

After the self-selected groupwork activity, the lecturer presented a PowerPoint presentation of all measurable items for superstructure brickwork (simple single story structure as per curriculum) based on the Standard System of Measuring Building Work (SSMBW). The primary purpose of the second scaffolding activity was to help students understand the SSMBW and the applicable measurement rules. Various illustrations and pictures were included in the PowerPoint presentation and the applicable SSMBW rules to build on the possible knowledge gained from the collage activity. The main purpose of this activity was to help students understand the rules of the SSMBW and make the connection between the measurable items and the measurement rules.

6.3.2.3 Scaffolding 3 – Measurement Example: House 1 (combination of lecturer-led and active engagement)

Once the PowerPoint presentation had finished, the students and the lecturer worked through a measurement example together and discussed all the measurable items for superstructure brickwork and the rules applicable to the measurable items. A floor plan, measurements, dimsheets and applicable measurement rules were discussed in detail during the example. Students had hardcopy examples with them provided by the lecturer to follow the discussion. Students were requested to make notes on the floor plan and the dimsheets as the lecturer shared the drawing on a projector screen. This was an active engagement session between the lecturer and the students as well as among the students. The main purpose of the third scaffolding activity was to help students understand the rules of the SSMBW and to help them understand what they are measuring related to superstructure brickwork.

6.3.2.4 Faded scaffolding – Students measure on their own (peer and social engagement and independent work)

Following the example discussion, students were assigned to measure a different example individually. They were provided with a floor plan and dimsheets to execute the activity. Although each student was responsible for their taking-off on their dimsheets, they were permitted to collaborate within groups to discuss the floor plan and measurable items, rules and calculations. Faded scaffolding is a pedagogical approach where support for the student is gradually removed, enabling them to complete the task and achieve the outcome independently (Murray & Arroyo, 2002). In this activity, the lecturer was available to answer questions, and group members could also provide assistance. However, this support was temporary, requiring students to eventually engage in the measurement activity on their own.

The data obtained from the first intervention are presented in the next subsection. Pre- and post-tests, participant observations, and reflection data are presented.

6.3.3 Data Obtained from Intervention 1

Significant and invaluable empirical data were meticulously collected during the initial teaching intervention. The subsequent section presents the gathered data, the majority of which are qualitative by nature.

6.3.3.1 Pre- and Post-test data (N=18)

The first section of the worksheet (Q10) included a baseline knowledge determination and the pre-test (Q4). Students were prompted with specific questions on superstructure brickwork and construction to engage their thoughts and tap into their existing and prior knowledge base about superstructure brickwork. The primary aim of conducting pre- and post-tests is to assess the effectiveness of the applied teaching interventions and activities. After completion of the teaching interventions, students completed the post-test (Q10). These two values were compared and the data retrieved from the pre- and post-tests revealed the following:

Six students reported an increase in their knowledge and understanding. In comparison, four students noted a decline, and five students reported no change in their knowledge and understanding of superstructure brickwork after the teaching interventions. Three students did not respond to this question. This encounter of measuring pre- and post-lecture knowledge might be the first for students with such an information request, leading to a possibility that they did not grasp the question entirely. Nevertheless, the majority of the students reported an increase in their knowledge from before the lecture to after the implementation of teaching interventions. Therefore, it can be concluded that the interventions were effective.

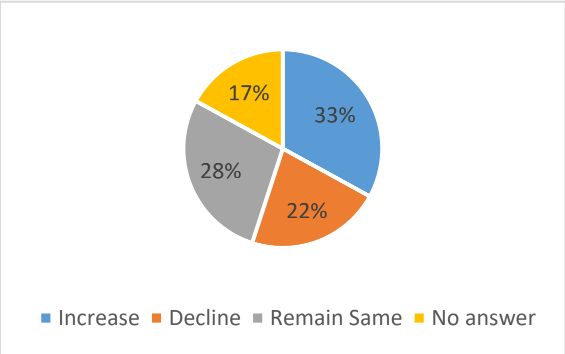


Figure 6.4: Pre- and Post-test Data: Intervention 1

6.3.3.2 Student Reflection Intervention 1 (Independent work)

The final section of the worksheet included a section dedicated to student reflection. It comprised Likert Scale questions as well as open-ended questions, thereby offering both quantitative and qualitative data. Subsequently, the questions and several responses to the reflection section are presented below.

When asked about the most effective teaching activity: Most students expressed that the measurement example discussion (Scaffolding 3), which involved active engagement between the lecturer and the students, significantly enhanced their comprehension of the measurement rules and material. Following closely in effectiveness was the PowerPoint presentation (Scaffolding 2) and the self-measure groupwork activity (faded scaffolding), which were deemed equally beneficial in their learning. However, the collage activity (Scaffolding 1), was perceived as the least effective teaching activity in facilitating their learning process. The fact that students did not experience this teaching activity as helpful was interesting, since I expected it to be a helpful learning experience.

When asked if students could make a connection between measurement elements and their applicable SSMBW rules, 16 students indicated they could successfully connect the measurable items and the applicable measurement (SSMBW) rules. Only one student indicated they could not connect the measurable items and the applicable SSMBW rules.

When asked which activity helped the students the most to make this connection, most of the students indicated that the PowerPoint presentation assisted them the most in connecting the measurable items and the SSMBW rules.

When tested on their time management capabilities, the majority (68%) of the students could not complete the various class (scaffolding) activities within the given timeframe. The fact that students could not finish the activities within the given timeframes indicates time management issues among students, which were also mentioned and acknowledged by students and lecturers in Methodology One.

In the next section, data from participant observations are presented.

6.3.3.3 Data from Lecturer's Observation Notes

The following observations during the lecture were noted by the lecturer. The observations were guided by participant observation prompts (see Appendix 14).

Table 6.3: Participant Observations Notes: Intervention 1

Participant Observation Prompts	Participant Observation Notes – Lecturer
What was the atmosphere in the class like today?	Upon receiving the worksheets, students appeared overwhelmed by the task at hand. The worksheet format seemed to contribute to students' feelings of being overwhelmed. During the baseline knowledge determination, some students shared some information that could slightly influence the outcomes of the baseline assessment and prior knowledge determination.

	However, this does not hold any significant consequences for this study. In the self-measure activity (faded scaffolding), students exhibited a **slow work pace** and appeared flustered and overwhelmed, resulting in an inability to complete the measurement activity within the allocated time frame. Students seem to struggle with time management.
Are students interested or bored?	During the collage activity, students demonstrated sociability and enjoyment**, with language not posing an issue;** however, they struggled with pacing, adhering to time constraints, and finishing the activity in the allocated timeframe.
What are my general observations of today's class?	Overall, students' **slow work pace was a recurring observation throughout the activities**. Another noteworthy observation by the lecturer was the **absence of any language barriers or issues among the students especially during the collage activity** where peer engagement was significant . This issue of language among students was mentioned in the lecturers' interviews and student focus groups; however, it was not supported with the observation of this student cohort.
Do I feel that I have achieved today's goal and outcomes?	Yes.
What can I do better or differently next week?	Create a separate worksheet and lesson plan.

6.3.3.4 Data from Lecturer's Reflection

After the lecture, I reflected upon all the activities and experiences during the lecture, highlighting several critical observations. The effectiveness of the PowerPoint presentation in facilitating student learning, particularly in establishing connections between measurable items and SSMBW measurement rules, is evident. Students' preference for PowerPoint presentations may stem from their familiarity with this format, which is often associated with traditional learning methods. To address the issue of students who seem overwhelmed at the beginning of the lecture, a structured lesson plan for the lecturer and a simplified worksheet for students could serve as practical facilitation tools, ensuring students do not feel overwhelmed by the extensive document. Furthermore, students' struggles with time management, as observed in both focus-group discussions and lecturer interviews, underscore the need for improved time management skills among students.

Despite initial expectations, the collage activity did not yield the anticipated learning outcomes, highlighting a discrepancy between expectation and experience by the lecturer. Additionally, there is a question regarding the possibility of spreading scaffolding teaching activities over multiple lectures or weeks instead of concentrating them within a single session. Lastly, the challenges faced in navigating through the lecture content pose a challenge for the lecturer, warranting further consideration and potential adjustments to the teaching approach and tools.

Table 6.4 summarises the challenges addressed during the different teaching activities, along with the corresponding findings of these activities in response to the identified challenges.

Table 6.4: Possible Solutions to Challenges: Intervention 1

Meta-Themes	Challenges Addressed in Intervention 1	Teaching Activity	Findings of Teaching Intervention
Pedagogy	Students struggle to make meaningful connections with other modules such as Building Technology, Drawings etc. Students struggle to make connections between modules and realise the interconnection of the curriculum.		Earlier in the semester, students attended a site visit (for the Building Science Module) where brickwork construction was underway on site, and students reported they were able to make a connection between the content discussion of the Building Science Module and the content of the discussion today in this module. **Through prompting from the lecturer connections can be made to other modules. Effective communication between the lecturers is important.**

Content	Students struggle with terminology and formulas and measurement rules. The building measurement module is a challenge; theory and new concepts are hard.	PowerPoint Presentation (Scaffolding 2) Measurement Example Discussion (Scaffolding 3) Self-Measurement Example (Faded scaffolding)	Students reported in their reflection section about the value of the teaching activities. The PowerPoint presentation being the most helpful teaching activity which helped the students to make connections between measurement rules and items. The example discussion and the self-measure activity was also effective in helping students to understand the content.
Environment	Some students are afraid to ask questions in class.		The purpose of creating group discussions is to create a safe space where students can ask questions and not be afraid and to engage with peers in learning. In this instance a self-selected group set-up was implemented and students seem to enjoy the social interaction as reported in the observations and reflection data.
Prior Knowledge and Skill	Time management skills and scheduling are a problem for students. Students are ill-prepared, underprepared and have no or limited prior knowledge.	Collage activity (Scaffolding 1) Self-measurement example (Faded scaffolding) Baseline knowledge determination (Pre- and Post-tests)	This challenge is real and serious and no answer or solution could be provided through this intervention. Further investigation into next intervention. Students' underpreparedness, limited prior knowledge and lecturers assumption of prior knowledge were addressed in the baseline knowledge determination.

	Students lack prior knowledge and find it frustrating.		It is important to determine students' baseline knowledge or level of prior knowledge to be able to build the new knowledge on. Data on the pre- and post-test assisted
	The lecturer assumes prior knowledge and this frustrates the students.	Collage activity (Scaffolding 1)	
	Language barrier among students and between the lecturer and the students. Sometimes students understand concepts better and faster when explained to them in their first language. Different languages between students seem to be a problem.		From this intervention it was determined that students in this cohort did not experience any language barriers among themselves or between the students and the lecturer. As reported by participant observations.

Throughout Intervention 1, numerous valuable insights were gained. Initially, it became clear that the content of the worksheet should be simplified, indicating a need for decreased complexity and length. Creating a lesson plan for the lecturer and a corresponding worksheet for the students may be beneficial. Additionally, the reflection section should be separate from the worksheet to highlight the importance of reflection within the learning journey. In this intervention, the key elements of Vygotsky's theory, such as scaffolding, the ZPD, and the MKO are applicable. The data from the pre- and post-tests are evidence of students moving through their ZPD with the help of the MKO, which is their peers within the groupwork set-ups and the lecturer providing support and then fading the support in the faded scaffolding activity are also evident.

In the subsequent section, the second teaching intervention is introduced and examined. The discussion follows the same sequence as that of Intervention 1.

6.4 TEACHING INTERVENTION 2 (Floor Finishes and Applications)

The second teaching intervention addresses the meta-themes encompassing environment, content, and prior knowledge and skills. The specific challenges, discerned and selected from Table 5.8, are detailed in Table 6.3 below. This intervention primarily aims to address the challenges students face, including hesitancy in posing questions in class, deficiency in interpreting construction drawings, and limited prior knowledge. The content topic of floor finishes and applications was discussed. Section 6.4.1 explains the teaching intervention, followed by an explanation of scaffolding activities in section 6.4.2. Subsequently, section 6.4.3 presents the data gathered from this intervention through pre- and post-tests, observations and reflections.

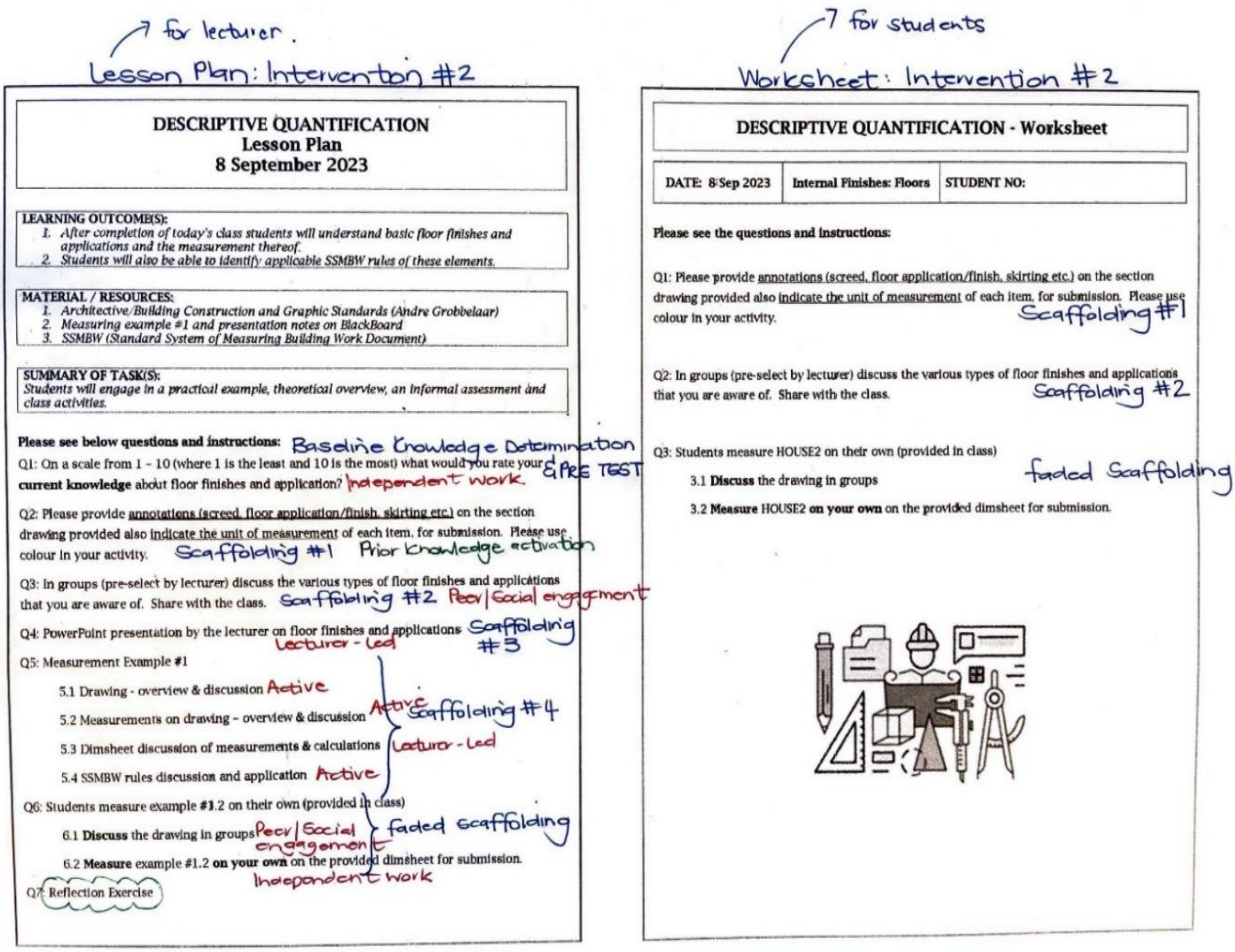
It is important to note that while all four teaching interventions were initially preplanned in response to identified challenges, feedback from the preceding interventions could inform and potentially alter certain aspects of the planned intervention. Modifications made for the second intervention, inspired by observations from the first intervention, primarily involved reducing the complexity of the worksheet. This led to the creation of a separate worksheet and lesson plan and the incorporation of a separate reflection section in the second intervention. In Table 6.5 below the meta-themes and challenges addressed in Intervention 2 are presented. The meta-themes of environment, content, and prior knowledge and skill are addressed.

Table 6.5: Teaching Intervention Two: Meta-Themes and Challenges Addressed

Interventions	Module Content Section	Meta-Themes	Challenges Addressed in Intervention 2
#2	Floor Finishes and Applications	Environment	- Some students are afraid to ask questions in class.

		Content	- Students cannot interpret or read construction drawings. - Students do not understand what they are measuring.
		Prior Knowledge and skill	- Students are ill-prepared, underprepared and have no or limited prior knowledge. Students lack prior knowledge and find it frustrating.

6.4.1 Teaching Intervention 2 Explained



for lecturer.

Lesson Plan: Intervention #2

DESCRIPTIVE QUANTIFICATION
Lesson Plan
8 September 2023

LEARNING OUTCOME(S):

1. *After completion of today's class students will understand basic floor finishes and applications and the measurement thereof.*
2. *Students will also be able to identify applicable SSMBW rules of these elements.*

MATERIAL / RESOURCES:

1. *Architective/Building Construction and Graphic Standards (Andre Grobbelaar)*
2. *Measuring example #1 and presentation notes on BlackBoard*
3. *SSMBW (Standard System of Measuring Building Work Document)*

SUMMARY OF TASK(S):
Students will engage in a practical example, theoretical overview, an informal assessment and class activities.

Please see below questions and instructions: Baseline Knowledge Determination

Q1: On a scale from 1 - 10 (where 1 is the least and 10 is the most) what would you rate your **current knowledge** about floor finishes and application? Independent work & PRE TEST

Q2: Please provide annotations (screed, floor application/finish, skirting etc.) on the section drawing provided also indicate the unit of measurement of each item, for submission. Please use colour in your activity. Scaffolding #1 Prior knowledge activation

Q3: In groups (pre-select by lecturer) discuss the various types of floor finishes and applications that you are aware of. Share with the class. Scaffolding #2 Peer/Social engagement

Q4: PowerPoint presentation by the lecturer on floor finishes and applications Lecturer-Led Scaffolding #3

Q5: Measurement Example #1

5.1 Drawing - overview & discussion Active

5.2 Measurements on drawing - overview & discussion Active

5.3 Dimsheet discussion of measurements & calculations Lecturer-Led

5.4 SSMBW rules discussion and application Active

Scaffolding #4

Q6: Students measure example #1.2 on their own (provided in class)

6.1 **Discuss** the drawing in groups Peer/Social engagement

6.2 **Measure** example #1.2 **on your own** on the provided dimsheet for submission. Independent work

faded scaffolding

Q7: Reflection Exercise

for students

Worksheet: Intervention #2

DESCRIPTIVE QUANTIFICATION - Worksheet

DATE: 8 Sep 2023	Internal Finishes: Floors	STUDENT NO:

Please see the questions and instructions:

Q1: Please provide annotations (screed, floor application/finish, skirting etc.) on the section drawing provided also indicate the unit of measurement of each item, for submission. Please use colour in your activity. Scaffolding #1

Q2: In groups (pre-select by lecturer) discuss the various types of floor finishes and applications that you are aware of. Share with the class. Scaffolding #2

Q3: Students measure HOUSE2 on their own (provided in class)

3.1 **Discuss** the drawing in groups

3.2 **Measure** HOUSE2 **on your own** on the provided dimsheet for submission.

faded Scaffolding

Figure 6.5: Intervention 2: Lesson Plan and Worksheet

As learned from Intervention 1, the second intervention had a separate worksheet and a lesson plan; the reflection sheet was also done separately from the worksheet in order not to overwhelm the students with information and activities. As shown in Figure 6.5, the lesson plan and worksheet were crafted separately (see Appendix 16-18). The principal aim of providing a lesson plan for the lecturer and a worksheet for the students is to introduce a structured approach to the lecture, enabling students to track the lecturer's presentation and actively participate in the discussions.

The lesson plan serves as a structured approach for the lecturer, and in the first section of the lesson plan the baseline knowledge determination activity and pre-test are indicated (Q1). Q2 on the lesson plan instructs the students to engage with the first scaffolding activity, Q3 gives an instruction to the third scaffolding activity. Q4 is the PowerPoint presentation by the lecturer on floor finishes and applications, which is referred to as scaffolding activity three. The fourth scaffolding activity is the measurement example discussion (Q5) and then in Q6 the faded scaffolding activity is indicated. The last section, Q7, of the lesson plan, is the reflection section.

The scaffolding activities are explained in detail in the next section, as this is core to the study.

6.4.2 Scaffolding Activities Explained: Intervention 2

Figure 6.6 depicts the various scaffolding activities applied in the second teaching intervention. Three layers of scaffolding (Figure 6.5, Q2–Q5) are applied and a faded scaffolding activity (Q6) is applied in this intervention.

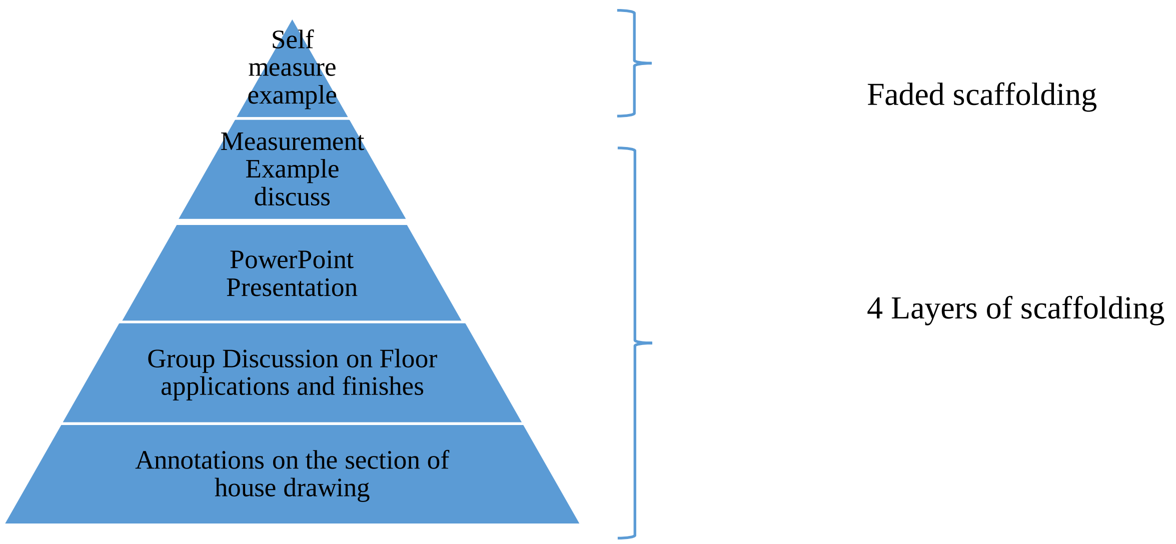


Figure 6.6: Scaffolding Activities Intervention 2

6.4.2.1 Scaffolding 1 – Annotations on section (independent work and prior knowledge activation)

In the first scaffolding activity, students were assigned to annotate a sectional drawing of a structure, focusing specifically on floor finishes and applications. Additionally, students were instructed to indicate the unit of measurement for each item and were encouraged to utilize coloured pencils and highlighters to emphasize important information and items on the drawing. The lecturer supplied the sectional drawing. This activity was conducted individually to activate students' prior knowledge of the content topic. Most students could only identify skirtings and floor coverings in the section correctly. Despite some slight inaccuracies in unit measurements, none of the students adhered to the instructions to utilize colour in the activity and delineate the various elements in colour on the section. This lack of compliance is concerning, indicating that students may not be carefully reading questions or instructions and are thus overlooking crucial details.

6.4.2.2 Scaffolding 2 – Group discussion (Peer and social engagement)

In the second scaffolding activity, students were assigned to discuss a range of floor finishes and applications within designated groups selected beforehand by the lecturer. Subsequently, each group was required to present the findings of their discussions to the rest of the class. The primary objective of this discussion was to foster active participation and encourage peer interaction among students. Importantly, the preselection of groups was deliberately implemented to assess students' attitudes towards this specific collaborative setup. The preselected approach was done randomly on the attendance list by the lecturer.

6.4.2.3 Scaffolding 3 PowerPoint (Lecturer-led)

Following the preselected groupwork activity, in Scaffolding 2, the lecturer conducted a PowerPoint presentation encompassing all measurable items relevant to the content topic of floor finishes and applications according to the SSMBW. The presentation included illustrations and pictures to supplement the students' understanding and further build upon their knowledge and insights obtained from the group discussions. The main purpose of the third scaffolding activity was to help students understand the rules of the SSMBW and to help them understand what they are measuring related to the content.

6.4.2.4 Scaffolding 4 – Measurement Example House 1 (Combination of lecturer-led and active engagement).

Similar to Intervention 1, once the PowerPoint presentation was finished, the students and the lecturer worked through a measurement example together and discussed all the measurable items for floor finishes and applications and the rules applicable to the measurable items. A floorplan, measurements, dimsheets and applicable measurement rules were discussed in detail during the example. Students had hardcopy examples with them provided by the lecturer to follow the discussion. Students were requested to make notes on the floorplan and the dimsheets as the lecturer shared the drawing on a projector screen. This was an active engagement session between the lecturer and the students as well as among the students to help them understand the items they were measuring.

6.4.2.5 Faded scaffolding (peer and social engagement and independent work)

Similar to the faded scaffolding approach in the first intervention, after the interactive example discussion, students were tasked with individually measuring a different example. They were furnished with a floorplan and dimsheets to carry out the activity, but unlike the first intervention's faded scaffolding, students were permitted to discuss the drawing in groups; however, they were required to measure on their own without assistance from other group members for calculations and measurable items.

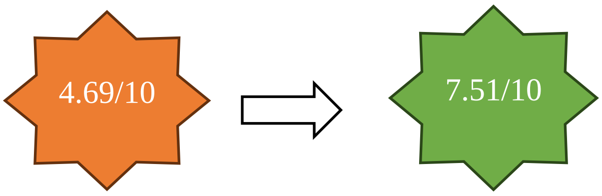
The next subsection presents the data obtained from the second intervention. Pre- and post-tests, participant observations and reflection data are presented.

6.4.3 Data obtained from Intervention 2

Valuable data were collected from Intervention 2, and data from the pre- and post-tests, participant observations and reflections are presented in the subsequent subsections. A total of 22 students attended the class.

6.4.3.1 Pre and Post Tests Data (n=22)

All 22 students who participated in the pre- and post-test sections of this intervention reported a significant increase in their knowledge from before the teaching activities and interventions to after completing them. An average score of 4.69 out of 10 was achieved in the pre-test and an average score of 7.51 out of 10 was achieved in the post-test. Thus, it seems the teaching interventions were proven successful and effective.



6.4.3.2 Student Reflection Intervention 2 Data (Independent work)

During this teaching intervention, students were given a separate reflection exercise (see Figure 6.7).

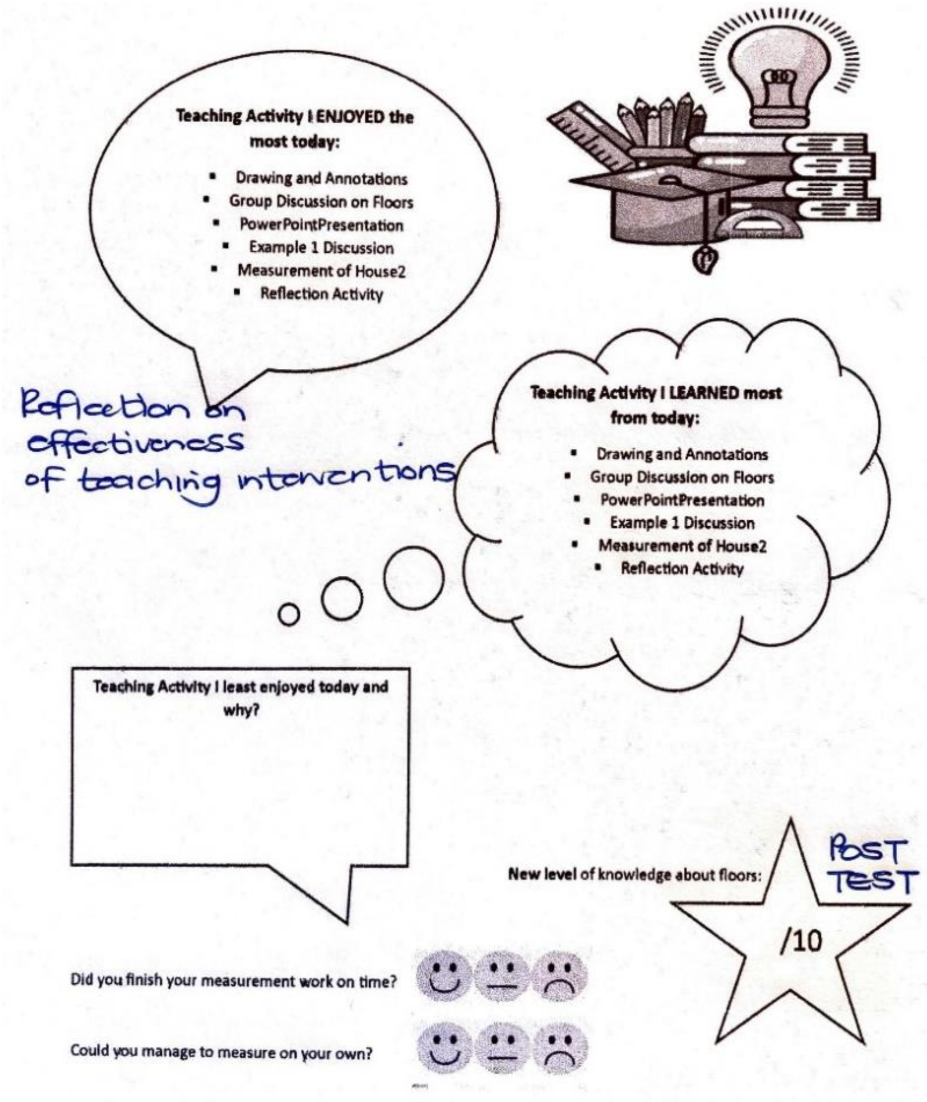


Figure 6.7: Student Reflection Exercise Intervention

In the reflection, students were prompted to identify the teaching activity they found most enjoyable, the activity from which they learned the most, and to specify the teaching activity they enjoyed the least. Additionally, they were required to report whether they completed the measurements within the provided time constraints and if they could conduct measurements independently.

When asked about the **most enjoyable teaching activity**, the following was reported:

Table 6.6: Most enjoyable teaching activity

	N=17	100%

Drawing and Annotations	2	12%
Group discussion about floors	**6**	**35%**
PowerPoint Presentation	2	12%
Example 1 Discussion	2	12%
Measurement of House 2	5	29%
Reflection activity	0	0%

From the data presented in Table 6.6, it is evident that students enjoy peer and social interaction and engagement. This is an essential aspect of the constructivist teaching approach. The groupwork setup in this intervention was different from the first intervention's groupwork setup. In this intervention (Scaffolding 2), the groupwork setup was based on a preselected basis by the lecturer. Even when placed in predetermined groups, students invariably seek opportunities to engage with one another, establishing a social environment that supports learning. Within this context, they feel comfortable asking questions and benefiting from one another's perspectives, thus enriching the educational environment.

When asked about the **activity they had learned most from**, the following was reported:

Table 6.7: Most Beneficial Learning Activity

	N=17	**100%**
Drawing and Annotations	0	0%
Group discussion about floors	2	12%
PowerPoint Presentation	**7**	**41%**
Example 1 Discussion	3	18%
Measurement of House 2	5	29%
Reflection activity	0	0%

These data suggest that students learned most from the PowerPoint presentation, and secondly, the example they had to measure on their own also provided them with a valuable learning opportunity. Interestingly, the most enjoyable teaching activity was the groupwork; however, the lecture's PowerPoint presentation was the activity they learned from the most.

In the reflection question about the **teaching activity that students least enjoyed**, some students indicated the activity they enjoyed most – indicating that they did not read the instruction. However, two students did not enjoy the example discussion, three students did not enjoy the measurement of floors exercise where they had to measure on their own, one student did not like the drawing and annotation activity, one student did not like the groupwork, and one student did not like the reflection section.

Students were also asked to reflect on their preselected group discussion experience. Most of them indicated that they had a positive experience. Only one student indicated an 'uncomfortable' experience ending in a group with unfamiliar students.

On the reflection sheet, the final two questions pertained to time management and independent work. When students were queried about their ability to complete the measurement tasks within the allocated time, only 11% could do so. Once again, time management skills are problematic. This was also evident in the first teaching intervention.

Did you **finish** your measurement work on time? (n=18)

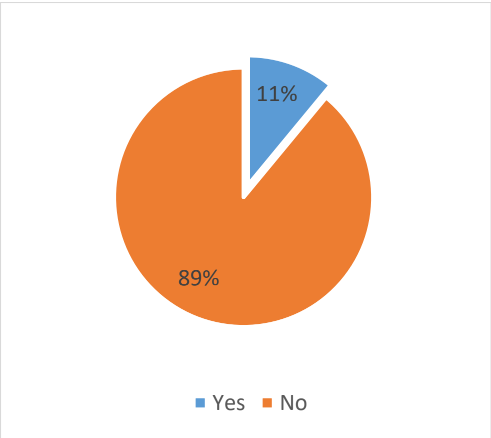


Figure 6.8: Time management skills

When students reported on their ability to work independently, the majority (78%) of them indicated that they could work independently.

Could you manage to measure on your own? (n=18)

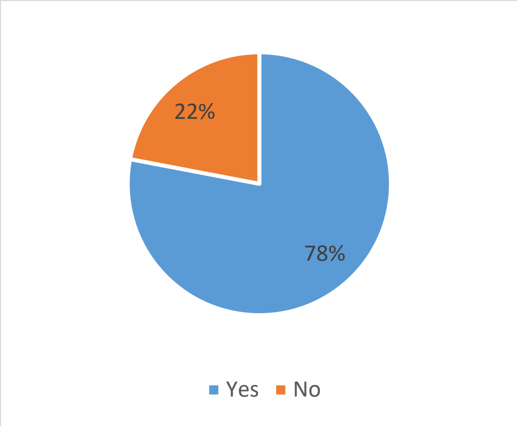


Figure 6.9: Independent measurement

In the next section, data from the lecturer's observations are presented.

6.4.3.3 Data from Lecturer's Observation Notes

The lecturer noted the following observations during the lecture:

Table 6.8: Participant Observation Notes: Intervention 2

Participant Observation Prompts	Participant Observation Notes – Lecturer
What was the atmosphere in the class like today?	The lecturer noted positive observations regarding the groupwork and overall student participation, with the exception of one group displaying signs of discomfort. (The class was divided into six groups of three students each, with one group consisting of four members). Today's groupwork was on a preselected basis, selected by lecturer, students were unable to select their own group members.
Are students interested or bored?	Overall, students exhibited **high levels of engagement** and positivity throughout the session.
What are my general observations of today's class?	During exercises requiring individual work, students **demonstrated proficiency in working independently**.

	However, there were instances where students worked at a **slower pace** and felt pressured to complete tasks within the allotted timeframes. Notably, a significant observation was the tendency of some students to **not fully listen to instructions** provided by the lecturer, suggesting a need for improved attentiveness during class activities.
Do I feel that I have achieved today's goal and outcomes?	Yes
What can I do better or differently next week?	Next week I want to apply a different groupwork set-up

6.4.3.4 Data from Lecturer's Reflection

Despite experience and preparation as a lecturer, I continue to face difficulties in effectively managing all aspects of the lecture. The complexities involved in delivering comprehensive instruction while attending to student needs and facilitating engagement remain an ongoing challenge. The question arises whether it would be possible and beneficial to implement a standardized framework for all teaching activities and interventions. Such a framework could potentially streamline the planning processes, enhance consistency and provide clarity for both the students and me. In Table 6.9 below, possible solutions to the challenges investigated in Intervention 2 are presented based on the data collected from pre- and post-tests, reflections and participant observations.

Table 6.9: Possible Solutions to Identified Challenges: Intervention 2

Meta-Themes	Challenges Addressed in Intervention 2	Teaching Interventions	Findings of Teaching Intervention
Environment	Some students are afraid to ask questions in class	Groupwork activities	Despite the preselection, students found the groupwork setup enjoyable. This facilitated an environment where students could learn from each other and feel comfortable asking questions. Peers acting as MKOs. This was reported through the reflection and observation data.
Content	Students cannot interpret or read construction drawings Students do not understand what they are measuring.	PowerPoint presentation	During the PowerPoint presentation, as well as the measurement example where students measured on their own, assisted them in their learning. Interestingly, the students did not find the drawing annotations activity as helpful in their learning, but they enjoyed it.
Prior Knowledge and skill	Students are ill-prepared, underprepared and have no or limited prior knowledge. Students lack prior knowledge and find it frustrating.	Pre- and post-test activities.	The activity aimed at determining baseline knowledge and activating prior knowledge proved effective in getting the students started and engaged in this session. Data from the pre- and post-tests support this.

From these data presented in the table the effectiveness of the teaching interventions in terms of addressing the identified challenges can be seen. In the next section the third teaching intervention is presented.

6.5 TEACHING INTERVENTION 3 (Ceiling Finishes and Application)

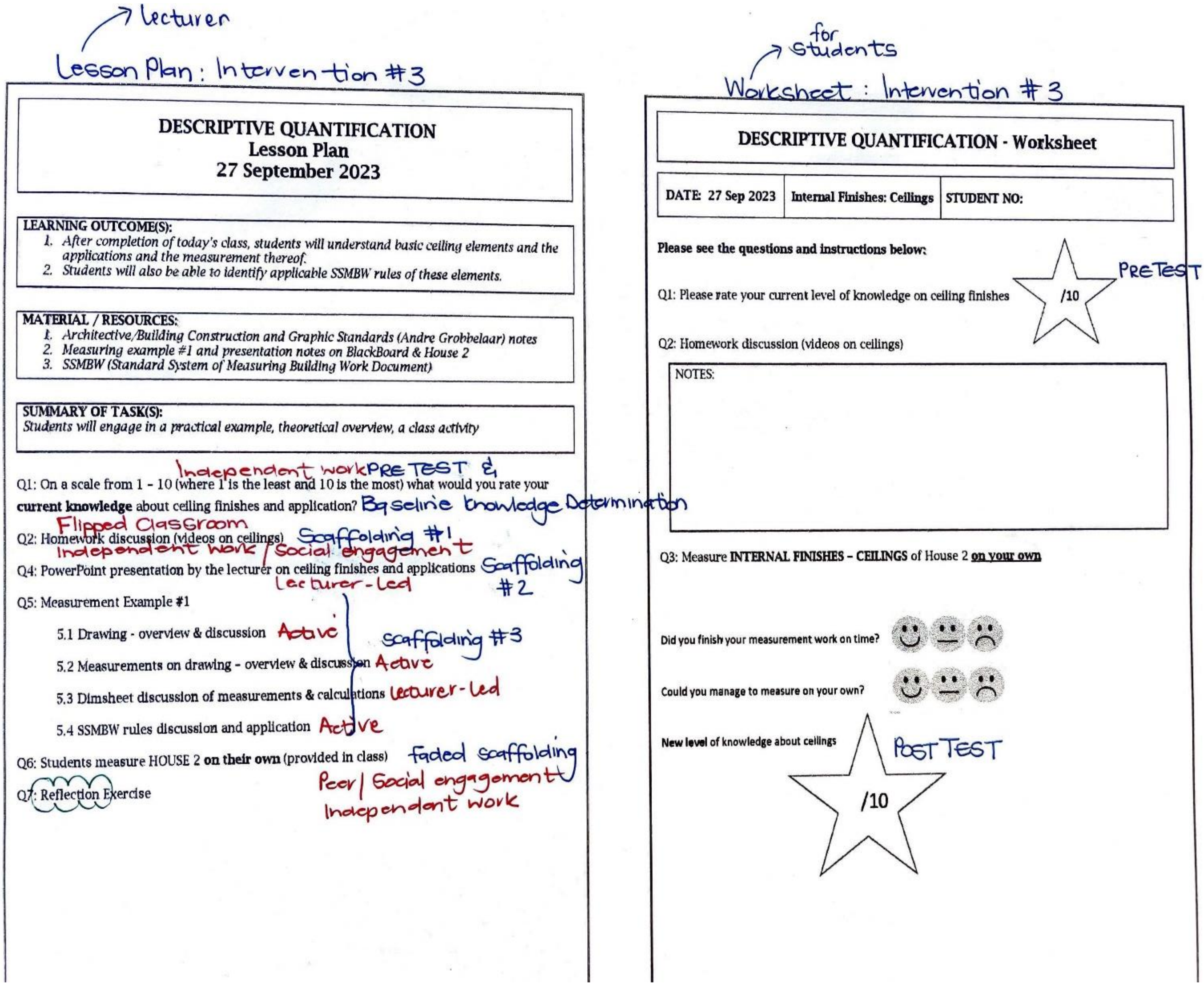
For the third intervention, similar to the second intervention, a separate lesson plan, worksheet, and reflection sheet were created and handed out to the students. The content topic was ceiling finishes and installations. This intervention addresses the meta-themes of pedagogy, environment and prior knowledge and skill with a specific focus to the following challenges: students' inability to link modules, reluctance to ask questions in class and students' limited prior knowledge. Some of these challenges were also addressed in the previous interventions, the reason for inclusion in the third intervention again is to test possible alternative solutions as well. In section 6.5.1, the teaching intervention is explained, and in 6.5.2, the various scaffolding teaching activities are elaborated on. In section 6.5.3 the data obtained from this intervention are presented. Data obtained from pre- and post-tests, observations and reflection are presented and discussed. In the Table 6.15 possible solutions to the identified challenges are presented based on the data collected. In the table below, Table 6.10, the meta-themes and challenges addressed in the third intervention are presented.

Table 6.10: Teaching Intervention 3: Meta-Themes and Challenges Addressed

Interventions	**Module Content Section**	**Meta-Themes**	**Challenges Addressed in Intervention 3**
#3	Ceiling Finishes and Installations	Pedagogy	- Students struggle to make meaningful connections with other modules such as Building Technology, Drawings etc. Students struggle to make connections between modules and realise the interconnection of the curriculum.
		Environment	- Some students are afraid to ask questions in class.
		Prior Knowledge and skill	- Students lack prior knowledge and find it frustrating. Students are ill-prepared, underprepared and have no or limited prior knowledge.

6.5.1 Teaching Intervention 3 Explained

This intervention starts with the implementation of a flipped classroom approach as the first scaffolding activity, the viability of this concept is tested in this intervention. The concept of flipped classroom is discussed in Chapter 2 (section 2.8). As illustrated in Figure 6.10, the initial section of the worksheet facilitated a pre-test (Q1) in Q2 (See Appendix 19-21). The worksheet encompassed several teaching activities, denoted as scaffolding, highlighting three layers of scaffolding, alongside a faded scaffolding activity. At the same time, as outlined on the lesson plan, students are involved in independent activities, social interactions, peer collaboration, and active engagement during the lecture, including segments of discussions and presentations led by the lecturer, all of which form part of the constructivist teaching approach. The flipped classroom approach was decided on as the first scaffolding activity whereby students had to engage and watch three videos on ceiling finishes and installations before class.



→ lecturer

Lesson Plan: Intervention #3

DESCRIPTIVE QUANTIFICATION
Lesson Plan
27 September 2023

LEARNING OUTCOME(S):
1. *After completion of today's class, students will understand basic ceiling elements and the applications and the measurement thereof.*
2. *Students will also be able to identify applicable SSMBW rules of these elements.*

MATERIAL / RESOURCES:
1. *Architective/Building Construction and Graphic Standards (Andre Grobbelaar) notes*
2. *Measuring example #1 and presentation notes on BlackBoard & House 2*
3. *SSMBW (Standard System of Measuring Building Work Document)*

SUMMARY OF TASK(S):
Students will engage in a practical example, theoretical overview, a class activity

Independent work PRETEST &

Q1: On a scale from 1 – 10 (where 1 is the least and 10 is the most) what would you rate your **current knowledge** about ceiling finishes and application? Baseline knowledge Determination

Flipped Classroom

Q2: Homework discussion (videos on ceilings) Scaffolding #1

Independent work / Social engagement

Q4: PowerPoint presentation by the lecturer on ceiling finishes and applications Scaffolding #2

Lecturer-Led

Q5: Measurement Example #1

5.1 Drawing - overview & discussion Active

5.2 Measurements on drawing - overview & discussion Active

Scaffolding #3

5.3 Dimsheet discussion of measurements & calculations Lecturer-Led

5.4 SSMBW rules discussion and application Active

Q6: Students measure HOUSE 2 **on their own** (provided in class) Faded scaffolding

Q7: Reflection Exercise Peer / Social engagement

Independent work

→ for Students

Worksheet: Intervention #3

DESCRIPTIVE QUANTIFICATION - Worksheet

DATE: 27 Sep 2023	Internal Finishes: Ceilings	STUDENT NO:

Please see the questions and instructions below:

Q1: Please rate your current level of knowledge on ceiling finishes /10 PRETEST

Q2: Homework discussion (videos on ceilings)

NOTES:

Q3: Measure **INTERNAL FINISHES – CEILINGS** of House 2 **on your own**

Did you finish your measurement work on time?

Could you manage to measure on your own?

New level of knowledge about ceilings POST TEST /10

Figure 6.10: Lesson plan and Worksheet: Intervention 3

6.5.2 Scaffolding Activities Explained

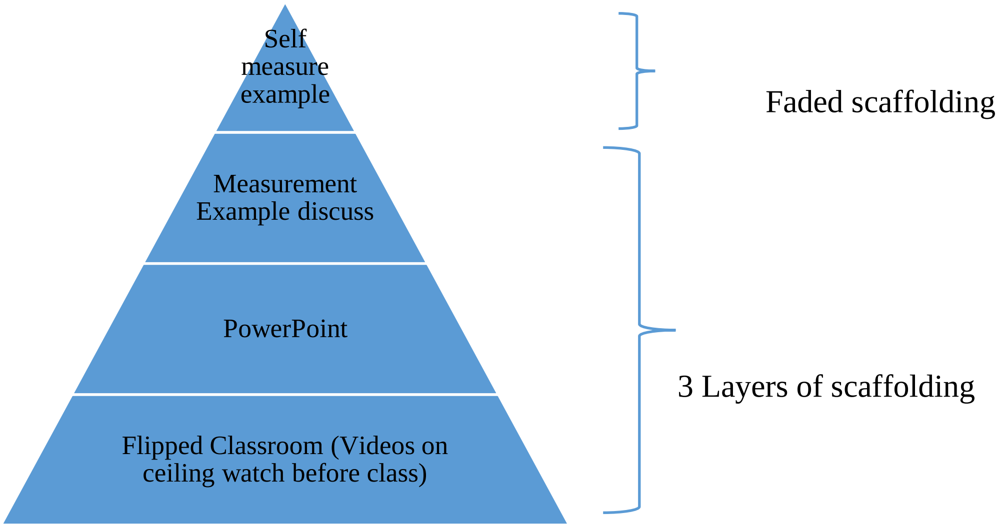


Figure 6.11: Scaffolding Activities Intervention 3

6.5.2.1 Scaffolding 1 – Flipped Classroom Homework (independent work)

I implemented and evaluated a flipped classroom approach during the initial scaffolding activity. This method reverses the traditional teaching model, requiring students to interact with course materials before the lecture. This preliminary engagement encompasses watching videos, reading, or participating in discussions. By arriving prepared for in-class discussions, students can actively engage with the material, maximizing opportunities for interactive learning during lectures. Specifically, students were tasked with watching three videos demonstrating ceiling installation.

6.5.2.2 Scaffolding 2 – PowerPoint presentation (Lecturer-Led)

In Scaffolding 2, I delivered a comprehensive PowerPoint presentation covering all measurable aspects pertinent to ceiling finishing and installation as per the SSMBW rules. The presentation featured various illustrations and images to enhance the students' comprehension and understanding of the measurable items.

6.5.2.3 Scaffolding 3 – Measurement Example House 1 (Combination of lecturer-led and active engagement)

Following the PowerPoint presentation, mirroring the format of teaching Interventions 1 and 2, a measurement example was discussed. The discussion explored a specific example where drawings, specifications, dimsheets, and SSMBW rules were thoroughly examined and discussed. A floor plan, measurements, dimsheets, and applicable measurement rules were discussed in detail during the example. Students had hardcopy examples with them provided by the lecturer to follow the discussion. Students were requested to make notes on the floor plan and the dimsheets as the lecturer shared the drawing on a projector screen. This was an active engagement session between the lecturer and the students as well as among the students.

6.5.2.4 Faded scaffolding (Independent work)

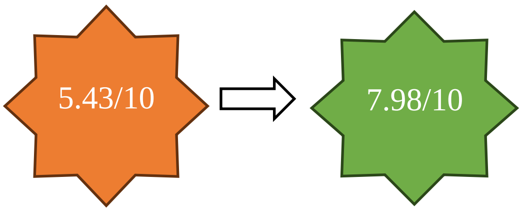
In alignment with Interventions 1 and 2, after the interactive example discussion, students were tasked with individually measuring a different example. They were furnished with a floor plan and dimsheets to facilitate this activity. Diverging from previous interventions, students were required to complete this exercise independently, without assistance from their peers for calculations and measurable items.

6.5.3 Data obtained from Intervention 3

Data from the pre- and post-tests, lecturer observations and students' reflections are presented in this subsection. 20 students attended the class and all 20 students submitted the worksheet.

6.5.3.1 Pre- and Post-tests Data (n=20)

All 20 students indicated that their knowledge increased significantly from before the teaching activities and interventions to after the activities and scaffolding interventions. Students scored an average of 5.43 out of 10 on the pre-test, and in the post-test, the average score increased to an average of 7.98 out of 10. Once again the effectiveness of the teaching interventions based on Vygotsky's theory are proven to be effective.



6.5.3.2 Student Reflection Intervention 3 Data (Independent work)

In this intervention, the reflection component was also separate from the worksheet. The reflection exercise prompted students to provide feedback on four specific areas. Firstly, they were encouraged to reflect on the extent to which watching pre-class videos on the topic of ceilings aided their understanding of the material. Following this, students were asked to identify the teaching activity from the session that resonated most with them. Additionally, they were questioned whether they believed preparatory work or reading before class, such as the concept of the flipped classroom approach, would enhance their comprehension. The final section (see Figure 6.12) the reflection exercise encouraged students to provide any additional comments they deemed relevant to today's lecture.

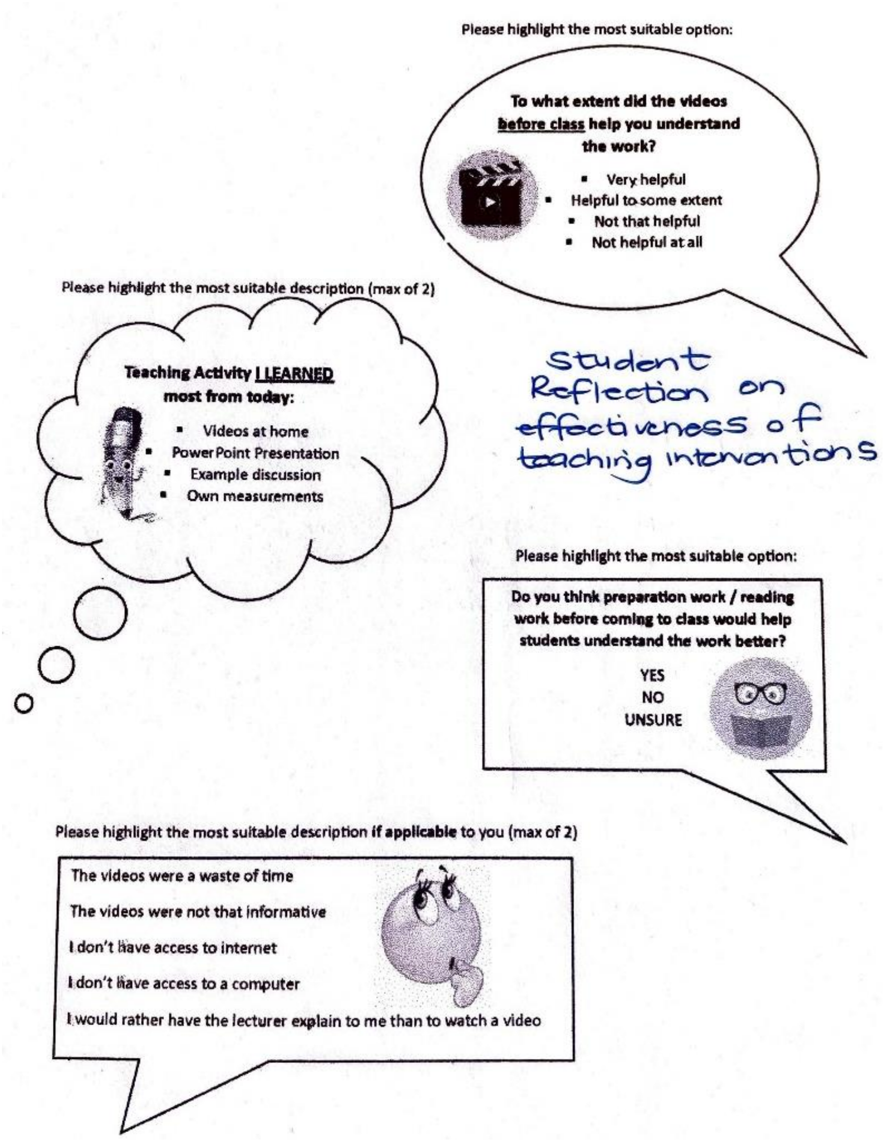


Figure 6.12: Reflection Intervention 3

When asked about the extent to which watching pre-class videos on the topic of ceilings aided their understanding of the material, the following were reported:

Table 6.11: Usefulness of Videos

	N=20	100%
Very helpful	7	35%
Helpful to some extent	**12**	**60%**
Not that helpful	1	5%
Not helpful at all	0	0%

These data suggest that the majority of the students found the videos helpful to watch prior to class.

When students were asked to identify the teaching activity from which they have **learned the most** the following was reported: (N=20) *(it is important to note that students were allowed to select more than one answer to this question).*

Table 6.12: Activity students learned the most from

Videos at home	**1**
PowerPoint Presentation	6
Example Discussion	**15**
Own measurements	8

From these data it is evident that students found the **example discussion** (scaffolding activity 3) most helpful and beneficial to their learning of the content topic of ceiling finishes and installations. Unfortunately, the videos at home were indicated as the least helpful learning activity compared to other teaching activities.

In the third reflection prompt, students were asked about whether they believed preparatory work, reading, or watching videos before class (flipped classroom approach) would enhance their comprehension and understanding of the content, the following was reported (N19).

Table 6.13: Preparatory Work

	N=19	**100%**
Yes	14	74%
No	0	0%
Unsure	5	26%

14 students agreed that preparation work/reading/or videos before coming to class are helpful, and five students indicated that they feel unsure about the helpfulness of preparatory work.

The final section of the reflection exercise encouraged students to provide any additional comments they deemed relevant. Some of the comments include:

> *I would rather have the lecturer explain to me than to watch videos.*
>
> *The videos were not that informative.*

On the worksheet, the last section also prompted students with some feedback on their ability to finish the measurement work on time and if they could manage to measure on their own. When asked if the students were able to finish their measurements on time (n=19), 12 students indicated that they were happy with their progress and were able to finish their measurements. Seven students indicated that they are unhappy with their progress and that there is room for improvement. Upon the question of whether students could cope with measuring on their own (n=19), 17 students indicated that they were comfortable measuring on their own.

6.5.3.3 Data from Lecturer's Observation Notes

In Table 6.14 below, the lecturer's observations during the third intervention are noted.

Table 6.14: Lecturer Observation Notes Intervention 3

Participant Observation Prompts	Participant Observation Notes – Lecturer
What was the atmosphere in the class like today?	Generally positive
Are students interested or bored?	Notably, during measurement work and example exercises, students appeared **notably more relaxed compared** to earlier in the semester.
What are my general observations of today's class?	Concerning the flipped classroom approach, most students actively engaged by watching the videos before the lecture, providing feedback on their experiences, and participating actively in class discussions. A noteworthy observation was the **students' ability to link concepts between the Building**

	Science and Building Measurement modules, particularly evident in detailed discussions regarding the ceiling installation. Consequently, the content resonated more effectively with them, particularly in terms of comprehending measurement items.
Do I feel that I have achieved today's goal and outcomes?	Yes.
What can I do better or differently next week?	Nothing noted.

From the data obtained from the lecturers' observations, valuable information was collected. In the next section data from the lecturer's reflections are presented.

6.5.3.4 Data from Lecturer's Reflection

After completion of the class the lecturer reflected on the activities and noted that recognizing students by their names has proven to significantly enhance their engagement in the learning process. This personal acknowledgment fosters a sense of connection and accountability among students, encouraging active participation and contribution to discussions and activities. While the flipped classroom approach can be a valuable supplementary teaching method, it should not be solely relied upon for teaching measurable items within this module. Although it offers flexibility and self-paced learning benefits, certain topics and activities may necessitate additional in-person instruction or hands-on experiences to ensure comprehensive understanding and skill development. In the context of the measurement module, the flipped classroom approach may not be the most suitable instructional method. Given the technical nature of measurement concepts and the need for hands-on practice, traditional classroom instruction supplemented by practical exercises and demonstrations is often more effective in facilitating learning outcomes.

The most noteworthy discovery from the third teaching intervention is the students' ability to connect the Building Science module and the Building Measurement module. Students indicated they had discussed the ceiling installation, methods, and materials in the Building Science Module, and now they already know when it is time to measure these items. Thus, it is crucial and helpful for the students to be able to make the connections. In Table 6.15 the responses to the identified challenges are presented.

Table 6.15: Response to Challenges: Intervention 3

Meta-Themes	Challenges Addressed in Intervention	Teaching Interventions	Response to Challenges
Pedagogy	Students struggle to make meaningful connections with other modules such as Building Technology, Drawings etc. Students struggle to make connections between modules and realise the interconnection of the curriculum.	PowerPoint presentation	It was evident in Scaffolding 2 that students were able to make a link between content discussions in the Building Science module and this module.
Environment	Some students are afraid to ask questions in class.	Self-measurement activity.	It is notable that students are more comfortable in class; knowing students by name makes them also feel more comfortable and engaged as reported in observations and reflections.
Prior Knowledge and skill	Students lack prior knowledge and find it frustrating. Students are ill-prepared, underprepared and have no or limited prior knowledge.	PowerPoint presentation and Measurement example discussion.	Students have some knowledge about this content, which was obtained in the Building Science module, not only is this prior knowledge that was gained there valuable but for students to be able to link the content is also of high value to learning in the building measurement module.

From the data collected in the third intervention possible solutions to the identified challenges were presented. In the next section Teaching Intervention 4 are presented and discussed.

6.6 TEACHING INTERVENTION 4 (Roofs & Roof Construction)

For the fourth teaching intervention, a separate lesson plan, worksheet, and reflection sheets were created and distributed in hardcopy to the students. The lesson plan provides structure for the lecturer for the lecture, and the worksheet and reflection sheets are for the students to follow. The focus of this intervention was on roofs and roof construction. Unlike the previous interventions, Teaching Intervention 4's scaffolding activities were spread out over two weeks, marking a change from the previous three interventions. In this teaching intervention, meta-themes addressed include pedagogy, environment, prior knowledge and skill. The specific challenges addressed included the need for more site visits, students' difficulty in linking modules, reluctance to ask questions in class, and students' limited ability to interpret 2D and 3D images, as well as a deficiency in students' prior knowledge. In the sub-section of 6.6.1, the teaching interventions are explained, followed by a discussion on the applied scaffolding activities in section 6.6.2. In section 6.6.3, data obtained from the pre- and post-test, observations, and reflections are presented. In Table 6.16 below the meta-themes as well as the identified challenges to be addressed in this intervention are presented.

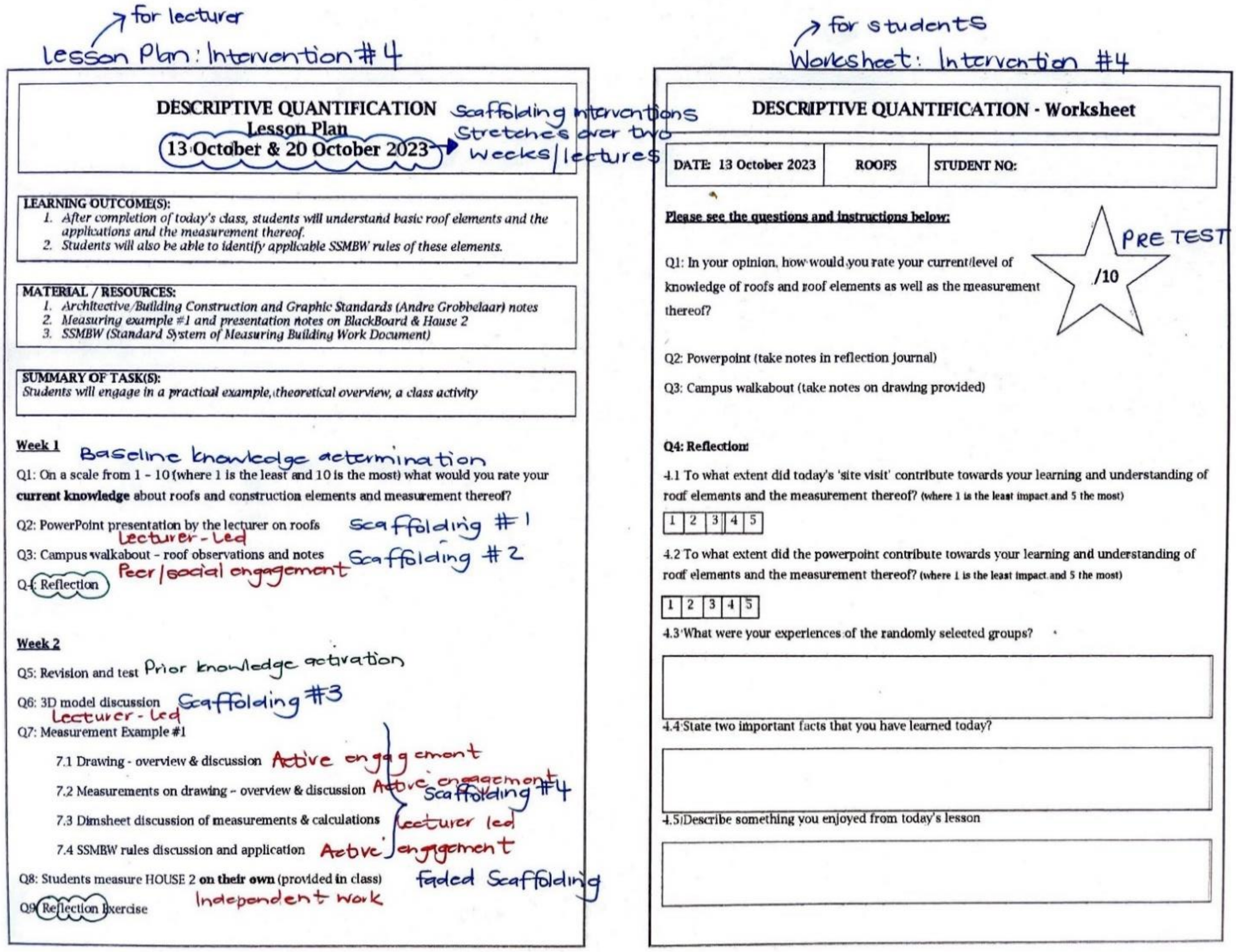
Table 6.16: Teaching Intervention Four

Interventions	Module Content Section	Meta-Themes	Challenges Addressed in Intervention 4
#4	Roof Construction	Pedagogy	- Lack of site visits - Students struggle to make connections between modules and realise the interconnection of the curriculum. Students struggle to make meaningful connections with other modules such as Building Technology, Drawings, etc.
		Environment	- Some students are afraid to ask questions in class.
		Prior Knowledge and skill	- Students struggle to visualise 2D and 3D images. - Students are ill-prepared, underprepared and have no or limited prior knowledge.

6.6.1 Teaching Intervention 4 Explained

For the fourth intervention, it was decided to stretch the scaffolding interventions over a two-week period to determine if the scaffolded teaching interventions would be effective and, if so, to what extent.

In the first week of the teaching intervention, like previous interventions, students received a hardcopy worksheet, which they needed to follow along with the lecture. In the first part of the teaching intervention, students' current knowledge was determined as part of a baseline knowledge determination, where students rated their current knowledge of roofs and roof construction elements (Figure 6.13, Q1). Then, there was a PowerPoint presentation followed by a site visit on campus. The site visit entailed the visual observation of an existing structure on campus. The lecture ended with student reflection and feedback on their learning and on the perceived effectiveness of the applied scaffolded teaching interventions. Lecturer observations and reflections are also presented (see Appendix 22-23).


for lecturer

Lesson Plan: Intervention #4

DESCRIPTIVE QUANTIFICATION
Lesson Plan
13 October & 20 October 2023

Scaffolding interventions stretches over two weeks/lectures

LEARNING OUTCOME(S):
1. *After completion of today's class, students will understand basic roof elements and the applications and the measurement thereof.*
2. *Students will also be able to identify applicable SSMBW rules of these elements.*

MATERIAL / RESOURCES:
1. *Architective/Building Construction and Graphic Standards (Andre Grobbelaar) notes*
2. *Measuring example #1 and presentation notes on BlackBoard & House 2*
3. *SSMBW (Standard System of Measuring Building Work Document)*

SUMMARY OF TASK(S):
Students will engage in a practical example, theoretical overview, a class activity

Week 1 Baseline knowledge determination

Q1: On a scale from 1 - 10 (where 1 is the least and 10 is the most) what would you rate your **current knowledge** about roofs and construction elements and measurement thereof?

Q2: PowerPoint presentation by the lecturer on roofs — Scaffolding #1 — Lecturer-Led

Q3: Campus walkabout - roof observations and notes — Scaffolding #2 — Peer/social engagement

Q4: Reflection

Week 2

Q5: Revision and test — Prior knowledge activation

Q6: 3D model discussion — Scaffolding #3 — Lecturer-Led

Q7: Measurement Example #1

7.1 Drawing - overview & discussion — Active engagement

7.2 Measurements on drawing - overview & discussion — Active engagement — Scaffolding #4

7.3 Dimsheet discussion of measurements & calculations — Lecturer led

7.4 SSMBW rules discussion and application — Active engagement

Q8: Students measure HOUSE 2 **on their own** (provided in class) — faded Scaffolding — Independent work

Q9: Reflection Exercise

for students

Worksheet: Intervention #4

DESCRIPTIVE QUANTIFICATION - Worksheet

DATE: 13 October 2023	ROOFS	STUDENT NO:

Please see the questions and instructions below:

PRE TEST — /10

Q1: In your opinion, how would you rate your current level of knowledge of roofs and roof elements as well as the measurement thereof?

Q2: Powerpoint (take notes in reflection journal)

Q3: Campus walkabout (take notes on drawing provided)

Q4: Reflection:

4.1 To what extent did today's 'site visit' contribute towards your learning and understanding of roof elements and the measurement thereof? (where 1 is the least impact and 5 the most)

1	2	3	4	5

4.2 To what extent did the powerpoint contribute towards your learning and understanding of roof elements and the measurement thereof? (where 1 is the least impact and 5 the most)

1	2	3	4	5

4.3 What were your experiences of the randomly selected groups?

4.4 State two important facts that you have learned today?

4.5 Describe something you enjoyed from today's lesson

Figure 6.13: Worksheet and Lesson plan Intervention 4

During the second week of this teaching intervention, the lecture began with a recap of the previous week's class and teaching activities. A 3D model demonstrating the measurement example was presented and discussed, followed by active participation from both the lecturer and the students in discussing the measurement example. Afterwards, students were required to independently measure another example. The lecture concluded with a reflective session.

6.6.2 Scaffolding Activities Explained

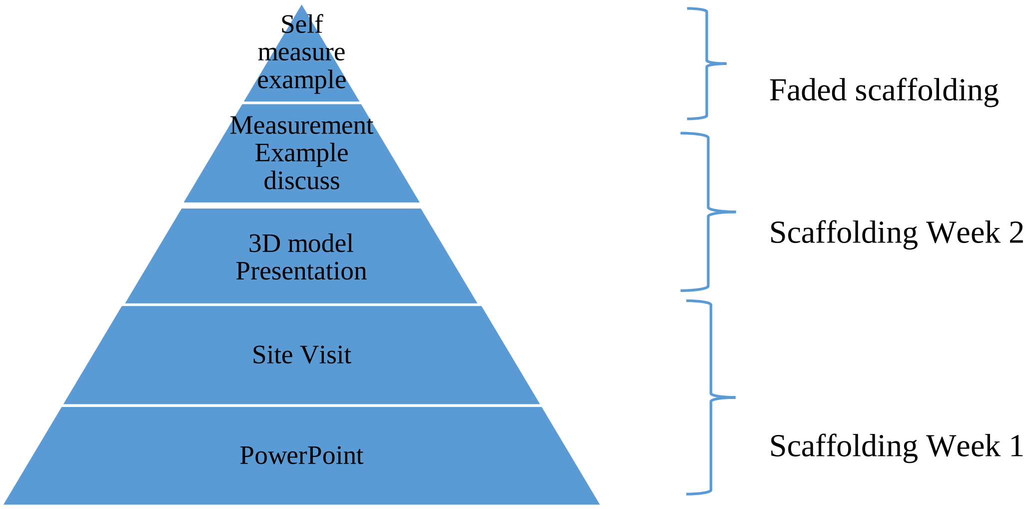


Figure 6.14: Scaffolding Activities Intervention 4

6.6.2.1 Scaffolding 1 (Week 1) – PowerPoint (Lecturer Led)

For the first scaffolding activity, the lecturer presented a PowerPoint presentation that included various images and photos of basic measurable items of roof construction and coverings encompassing all measurable items relevant to roof construction and coverings according to the SSMBW rules. The presentation included various illustrations and pictures to supplement the students' understanding and comprehension of roof construction elements and finishes.

6.6.2.2 Scaffolding 2 (Week 1) – Site Visit (Peer and Social Engagement)

For the second scaffolding activity, the students embarked on a campus walkabout or site visit to an existing single-story structure. Participants examined the external façade during this excursion, focusing on specific aspects such as roof construction, covering materials, and finishes. Equipped with a provided hardcopy drawing, students were tasked with locating and identifying various elements depicted on the drawing in real-time on the actual structure. Items, including roof coverings, downpipes, fascia and rafters, were among those to be pinpointed. The students were divided into six randomly selected groups. Group compositions varied, with one group comprising four members, four groups comprising three students each, and one group comprising two students. The intentional selection of groups at random was aimed at assessing students' capabilities and comfort levels in working with randomly assigned peers.

6.6.2.3 Scaffolding 3 (Week 2) – 3D Model Discussion (Lecturer Led & Active Engagement)

For the third scaffolding activity in Week 2, a never-before-seen 3D architectural model of the measurement example was presented. Before the measurement example in Scaffolding 4 was discussed, this 3D model was presented.

6.6.2.4 Scaffolding 4 (Week 2) – Measurement Example House 2 (Combination of lecturer Led & active engagement)

After the third scaffolding activity, the 3D model presentation, scaffolding activity four took place. This was a measurement example that was discussed. A floorplan, measurements, dimsheets, and applicable measurement rules were discussed in detail during the example. Students had hardcopy examples with them provided by the lecturer to follow the discussion. Students were requested to make notes on the floorplan and the dimsheets as the lecturer shared the drawing on a projector screen. The measurement example was an active engagement session between the lecturer and the students as well as among the students.

6.6.2.5 Faded Scaffolding Week 2 – Measurement Example (Individual Work)

The last scaffolding activity occurred as a faded scaffolding in Week 2, whereby students had to measure an example independently. They were furnished with a floorplan and dimsheets to carry out the activity. Still, unlike the first three interventions' faded scaffolding, students were required to measure independently without other group members' assistance.

6.6.3 Data Obtained from Intervention 4

Baseline knowledge determination. The class comprised 18 students, all of whom submitted their worksheets, with all 18 granting permission for data usage (n=18).

6.6.3.1 Pre- and Post-Tests Data

In the first week of the teaching interventions, students had to indicate their perceived level of knowledge about roof construction elements and finishes. Eighteen (18) students participated in this pre-test (Worksheet Q1). An average score of 4.83 out of 10 was determined in the pre-test. Thus, students did not score their baseline knowledge of the content topic very high. In the second week of the teaching interventions, students engaged in a revision test and had to, based on that score, indicate their new level of knowledge (see Figure 6.15). These two scores were compared with each other to establish the effectiveness of the teaching interventions. Sixteen students completed the post-test and an average score of 8.37 out of 10 was determined. Thus, students' knowledge increased significantly, from 4.83 to 8.37, after the various teaching interventions and applied scaffolding activities.

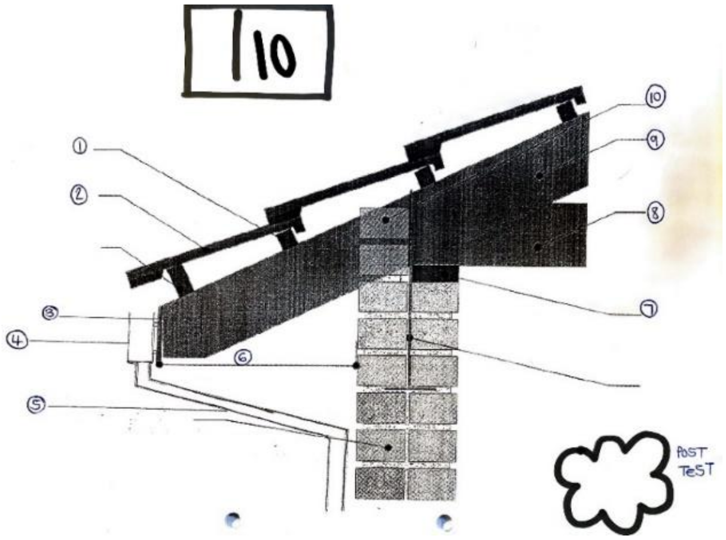


Figure 6.15: Post-Test Diagram: Intervention 4

6.6.3.2 Data from Student Reflection Data

Data obtained from the students' reflections over the two week period showed the following:

Week 1 Reflection:

When asked about their site visit experience: Out of 18 respondents, 83% (15 students) reported a positive learning experience from the walk-about/site visit, with a Likert scale rating of 4 or higher. (Where 1 is the lowest and 10 is the highest score).

When asked about the effectiveness of the PowerPoint presentation: Similarly, all 18 students indicated that it significantly contributed to their understanding of roofs, with a Likert scale rating of 4 or higher.

When asked about students' experience of the randomly selected groups: The majority of students (15) expressed positive experiences in the randomly selected groupwork set-up.

Week 2 Reflection:

In assessing the effectiveness of a teaching intervention conducted over two weeks, 18 out of 20 students found it highly beneficial and effective, noting that the extended duration of the implemented scaffolding and teaching interventions allowed them ample time to process and understand the concepts presented. Regarding the teaching impact of the 3D model, 15 students out of 20 reported that it significantly aided their learning, rating its effectiveness at a level of 7 out of 10 or higher.

6.6.3.3 Data from Lecturer's Observation Notes

During week one and week two of the applied teaching interventions the following observations from the lecturer were made:

Table 6.17: Lecturer Observation Notes Intervention 4 (Week 1)

Participant Observation Prompts	Participant Observation Notes - Lecturer
What was the atmosphere in the class like today?	Excitement about the walk-about.
Are students interested or bored?	During the walk-about the students observed more than was required from them regarding the drawing and annotations.
What are my general observations of today's class?	Students enjoyed the walk-about and the random selected groupwork. One group was dysfunctional, and the students did not mingle very well.
Do I feel that I have achieved today's goal and outcomes?	Yes.
What can I do better or differently next week?	Nothing noted.

In the second week of the intervention the following observations were made by the lecturer:

Table 6.18: Lecturer Observation Notes Intervention 4 (Week 2)

Participant Observation Prompts	Participant Observation Notes - Lecturer
What was the atmosphere in the class like today?	Students seem tired, overwhelmed and confused in this class. There, attention seems to be somewhere else, it might be due to year-end stress.
Are students interested or bored?	Students enjoyed the 3D model presentation and were able to make the connection between the 2D image and the 3D model. Their comprehension were clearly noticeable.
What are my general observations of today's class?	Students' progress and understanding is noticeable.
Do I feel that I have achieved today's goal and outcomes?	Yes.
What can I do better or differently next week?	Nothing noted.

6.6.3.4 Data from Lecturer's Reflection Notes

Week 1:

Existing buildings and structures uniquely contribute to students' learning experiences by offering diverse educational opportunities, and students possess the ability to acquire valuable knowledge of established structures.

Week 2:

Concerning scaffolding, it appears to be more effective when stretched over a long period, giving them more time to grasp some concepts.

Table 6.19: Response to Challenges: Intervention 4

Meta-Themes	Challenges Addressed in Intervention 4	Teaching Intervention	Response to Challenges
Pedagogy	Lack of site visits Students struggle to make connections between modules and realise the interconnection of the curriculum. Students struggle to make meaningful connections with other modules such as Building Technology, Drawings, etc.	Site visit	It is possible to take students to **an existing structure** for observation of construction methods, material and measurable items. Students were once again able to link the content of Building Science with the measurement module.
Environment	Some students are afraid to ask questions in class.	Site visit	During the randomly selected groupwork setup for the site visit students were still able to work together and discuss the work and learn from one another.
Prior Knowledge and skill	Students struggle to visualise 2D and 3D images..	3D model presentation	3D models of measurement examples can be useful as students mentioned it aided significantly in their understanding of the content.
	Students are ill-prepared, underprepared and have no or limited prior knowledge	Measurement Example discussion.	Students gain some knowledge in the building science module and it is very valuable

In Table 6.20 below the challenges and the possible solutions to the identified challenges are presented and discussed.

Table 6.20: Summary of challenges and addressed and possible solutions

Meta-Themes	Challenges Addressed in Intervention	Possible Solutions to Challenges
Pedagogy	- Students struggle to make meaningful connections with other modules such as Building Technology, Drawings etc. Students struggle to make connections between modules and realise the interconnection of the curriculum.	Students should be reminded about the applicability of the content of other modules, such as building science, to support the building measurement module. lecturers of these modules should also communicate with each other.
	- Lack of site visits	Accessing an active construction site might not always be possible, however, existing structures and observation of building components can also be a valuable practical learning experience
Content	- Students struggle with terminology and formulas and measurement rules. - The building measurement module is a challenge; theory and new concepts are hard. - Students cannot interpret or read construction drawings - Students do not understand what they are measuring.	A PowerPoint presentation still proves to be of high learning value for the students, especially when they have to link measurement rules with measurable items. Showing pictures, illustrations, and images also enhances their comprehension.
Environment	- Some students are afraid to ask questions in class.	Creating various groupwork set-ups for social interaction proved to be a safe space for students to ask questions and, in this, also learn from one another. Concept of MKO applicable.
Prior Knowledge and skill	- Time management skills and scheduling are a problem for students.	The issue of time management and the lack of time management skills among first-year students might need further investigation, and incorporation into teaching activities.
	- Students are ill-prepared, underprepared and have no or limited	Lecturers of the building measurement module should accept first-year

	prior knowledge. Students lack prior knowledge and find it frustrating - The lecturer assumes prior knowledge and this frustrates the students.	students who are underprepared and lack prior knowledge when entering their classes; however, it is important to first determine students' level of knowledge to be able to meet students at their level of knowledge and understanding. It is also important to support underprepared first-year students with scaffolding teaching activities.
	- Language barrier among students and between the lecturer and the students. Sometimes students understand concepts better and faster when explained to them in their first language. Different languages between students seem to be a problem.	Language forms an integral part of the learning process, and it should be identified early on in the year. In the interventions, no language issues were discovered.
	- Students struggle to visualise 2D and 3D images.	Presenting 3D modules of the measurement examples proves to be effective and enhances students' understanding

6.7 FINAL STUDENT REFLECTION ON TEACHING INTERVENTIONS

Following the implementation of the four teaching interventions, a concluding reflection session was conducted to glean students' insights regarding the various interventions' efficacy and to address any lingering questions not sufficiently covered during the interventions. The reflection comprised a total of 16 questions, encompassing both closed and open-ended formats, along with a Likert scale query. Participation in the reflection was voluntary and anonymous.

Part 1 – Close-ended questions and Likert Scale

The reflection survey results revealed that 69% of students acknowledged their ability to draw connections between the building measurement module and the building science module, with 75% emphasizing the significance of establishing this linkage between important modules and the positive impact it has on their learning experiences.

Furthermore, unanimous agreement was reached among all students regarding the value and utility of self-reflection as an effective learning tool.

Regarding tutorial sessions, students expressed satisfaction with the current structure and advocated for its continuation. Additionally, there was a consensus among students advocating for compulsory weekly tutorial sessions. However, a minority opinion emerged, with only three students suggesting that senior students could lead tutorial sessions instead of the lecturer.

In response to inquiries regarding technology integration within the module, out of a sample size of 16 students, a notable 94% expressed comfort with its utilization.

Additionally, when questioned about their perception of the lecturer’s pace, 81% of students found it reasonable and manageable, while 19% acknowledged it as fast-paced but manageable.

Table 6.21: Instructional Pace

Too fast, I could not keep up	**0%**
It was at a fast pace, but I managed to keep up	19%
It was a reasonable and manageable pace	81%
Too slow, I was bored	0%

When queried about their primary challenges throughout the year, students cited academic hurdles as the most formidable, closely followed by social and financial difficulties. No new information was introduced, indicating data saturation.

When students were asked about the effectiveness of certain teaching activities applied in the module, they indicated that the PowerPoint Presentations and the examples they measured were the most effective followed by tutorial classes. Students also regard groupwork as an effective teaching activity. No new information was introduced, indicating data saturation.

Part 2 – Open-ended questions

Students suggested that having a supportive lecturer, exposure to subject-related modules in high school, and introductory workshops at the onset of the year would alleviate the challenges stemming from limited or lacking prior knowledge. Students proposed that informing high school students about the quantity surveying qualification and its implications through school visits would be beneficial. Additionally, they reiterated the importance of introducing subject-related modules in high school to further aid in preparation. Some of the suggestions from the students include the following:

> *Subject related to this module should be introduced in high school.*
>
> *The faculty should host events for school children to inform them about this course and what we do.*
>
> *I think what helped my year is an understanding lecturer that was willing to go the extra mile.*

6.8 VYGOTSKY'S THEORY OF SOCIOCULTURAL DEVELOPMENT – CASE-STUDY APPLICATION

6.8.1 Constructivism and Vygotsky

As outlined in Chapter 3 (section 3.3), the fundamental characteristics of constructivism encompass active learning and knowledge construction, integration of real-life scenarios, utilization of diverse media, social interaction, and provision of varied learning opportunities. Vygotsky's theory of sociocultural development, rooted in constructivism, places particular emphasis on elements such as MKOs, language, scaffolding, and the ZPD.

6.8.2 More Knowledgeable Others/Social Interaction

Students recognize their peers as MKOs who provide significant assistance in learning. Despite variations in the setups of groupwork and peer engagement across different interventions – ranging from self-selected to randomly selected and preselected groups, students consistently enjoy groupwork and find it effective for their learning, it also creates a safe environment where students can feel comfortable to ask questions. Social learning is a key concept of Vygotsky's theory, where MKOs form an integral part of the learning process. This study determined and can confirm the significance of social interaction in the learning process as reported by the students in their reflections as well as in the lecturer's observations. Additionally, the role of the MKO is evident in the diverse groupwork setups tested during the interventions, where students interacted with peers who served as potential MKOs or received support from the lecturer acting as the MKO. The teaching interventions also reflect general concepts of constructivism, which have proven effective in addressing challenges within the first-year building measurement module. Key constructivist principles such as active learning, prior knowledge activation, social interaction, scaffolding, and reflection have been invaluable in facilitating learning and teaching within this module.

6.8.3 Language

During the teaching interventions, no language barrier was observed among the cohort, contradicting certain data gathered from focus groups and interview discussions. During one of the teaching interventions students where task with a group activity and the lecturer observed that there were no language challenges or barrier among the various groups. It was a self-selected group activity, and it might be that students with the same language grouped themselves together automatically. Language plays a significant role in the social construction of knowledge, and is also an important aspect of Vygotsky's theory.

It is worth noting that inner speech, a component of language, is utilized in student self-reflection exercises implemented throughout the teaching interventions, reflection is recognized as a critical element in the learning process. Reflection is also an important aspect of constructivism. As noted in student reflections it was noted that students perceive reflections as valuable learning tool.

6.8.4 Scaffolding

Scaffolding refers to the temporary support provided to learners by a MKO. New knowledge is constructed based on existing knowledge, underscoring the importance of determining students' baseline and prior knowledge levels through the pre- and post-test activities. Scaffolding aims to break down complex tasks or outcomes into smaller, more manageable tasks. It provides clear direction and minimizes students' confusion regarding the task at hand. Additionally, scaffolding ensures that students remain focused on the task, significantly aiding their comprehension, especially in the building measurement module. Various scaffolding activities are available and can be implemented as teaching strategies. However, since scaffolding is temporary, it is crucial to remove it gradually, a process known as faded scaffolding. During faded scaffolding, students begin to independently engage in activities they were previously unable to accomplish alone. For example, in the first teaching intervention, the collage activity was the first scaffolding activity and the PowerPoint presentation was the second applied scaffolding activity. The third scaffolding activity was the example discussion and the faded scaffolding was the self-measure example.

In the teaching interventions where scaffolding was applied, the process involved first identifying the teaching activity as scaffolding, then implementing it. Collaborative learning and social interaction were deemed vital during this stage. Finally, the learning outcomes were assessed primarily through reflection. Reflection from the lecturer and from the students on the implemented teaching activities during the interventions.

6.8.5 Zone of Proximal Development

Evidence of students transcending their ZPD is apparent in the data gathered from pre- and post-test assessments conducted for each individual intervention. The effectiveness of the teaching interventions has been demonstrated across the four teaching interventions grounded in Vygotsky's sociocultural development theory and its key components like scaffolding, ZPD, and MKO. Students moving through the ZPD are evident in the data. Scaffolding activities and the support of the MKO assisted students to move through the ZPD. There is no universal ZPD for the students, each student has their own ZPD as each induvial has different levels of development and comprehension. Not only do students move through the ZPD in one unit outcome but also through the academic year they move through their ZPD and their whole duration of their studies as well, meaning from year one to year four they will transcend the ZPD.

6.9 CHAPTER SUMMARY

This chapter introduced the second research methodology, which builds upon the first methodology as presented in Chapter 5. The primary objective of this methodology was to evaluate the applicability of Vygotsky's sociocultural development theory in addressing pedagogical challenges among first-year students and lecturers within the building measurement module. The case study was conducted at a single institution and focused on a cohort of first-year students enrolled in an accredited quantity surveying programme with specific interest in the building measurement module. It took place during the second semester of the 2023 academic year. The study entailed four distinct teaching interventions to determine the effectiveness of Vygotsky's theory and its components. Each intervention was meticulously planned and thoroughly described. After the interventions, data were gathered to assess their impact. The insights gathered from these interventions proved invaluable in understanding the phenomenon of pedagogical challenges among first-year students and lecturers in the building measurement module.

The effectiveness of these interventions has been demonstrated across the four teaching interventions grounded in Vygotsky's sociocultural development theory and its key components like scaffolding, ZPD, and MKO. Evidence of students transcending their ZPD is apparent in the data gathered from pre- and post-test assessments conducted for each intervention. Additionally, the role of the MKO is evident in the diverse groupwork setups tested during the interventions, where students interacted with peers who served as potential MKOs, or received support from the lecturer acting as the MKO. The teaching interventions also reflect general concepts of constructivism, which have proven effective in addressing challenges within the first-year building measurement module. Key constructivist principles such as active learning, prior knowledge activation, social interaction, scaffolding and reflection have been invaluable in facilitating learning and teaching within this module. In the next Chapter, I will take a step back and reflect on the findings presented in Chapter 5 and Chapter 6 concerning the research questions this thesis set out to answer.

CHAPTER 7

CONCLUSION, RECOMMENDATION AND KNOWLEDGE CONTRIBUTION

7.1 INTRODUCTION

The first chapter of this study introduced the study by outlining its rationale and problem statement. This was followed by a comprehensive review of the literature on learning and teaching in the quantity surveying profession and within the context of higher education in Chapter 2. Chapter 3 explored various teaching theories and approaches, with a particular focus on constructivism and Vygotsky's theory of sociocultural development. Chapter 4 detailed the study's research methodologies, which included a convergent mixed-method and a case-study approach. In Chapter 5, the results and findings of the first methodology were presented, analysed and discussed. These findings informed the second methodology described in the case-study approach. Chapter 6 then presented the findings of the case study.

In essence this study aimed to address the pedagogical challenges encountered by first-year students and lecturers in the building measurement module at South African universities offering accredited quantity surveying programmes. However, lacking contextual knowledge of these challenges, this study employed two different, but compatible research methodologies. The first methodology sought to investigate and identify the challenges experienced by students and lecturers, while the second studied and evaluated constructivism, particularly Vygotsky's sociocultural development theory, as a potential learning and teaching approach to mitigate these challenges. Through a case-study design, the second methodology aimed to provide insights into these challenges and propose a facilitation framework to counter these challenges and to ultimately enhance learning and teaching of quantity surveying students.

The researcher, drawing on extensive teaching and industry experience, acknowledges the influence of personal biases and is committed to maintaining transparency, reflexivity, and ethical rigor throughout the study to ensure a balanced and objective exploration of pedagogical challenges in the building measurement module as stated in the positionality statement in chapter 4 (see section 4.10)

Chapter 7 serves to reintroduce the research questions and offer explicit answers based on data gathered from both methodologies. Additionally, it presents the facilitation framework developed in response to one of the subsidiary research questions. The implications for implementing this framework are discussed, alongside the study's limitations, recommendations and the study's knowledge contribution.

7.2 RESEARCH QUESTIONS

The main research question for this study is: How can the learning and teaching of first-year students in the building measurement module be enhanced through a facilitation framework?

From this main research question, various subsidiary questions were formulated. The subsidiary questions are presented in the subsequent sections, and answers are provided to these questions based on the findings of the empirical research and data collected for the two methodologies.

7.2.1 What is the extent of the preparedness level of first-year quantity surveying students in terms of prior knowledge or lack thereof to deal with the building measurement module content when they enter tertiary education for the first time?

The first subsidiary research question addresses students' levels of preparedness and prior knowledge upon entering higher education. Discussions on these findings can be found in Chapter 5, sections 5.2.4, 5.3.2, and 5.4.2. It emerged that students perceive their secondary education as inadequate preparation for higher education, contributing to their sense of underpreparedness. Building measurement module lecturers across the all participating institutions expressed various insights and concerns regarding the lack of preparedness and readiness of first-year students in their classes. Additionally, concerns were raised about the declining quality of basic education. The data also revealed a consistent articulation gap between matriculation (grade 12) and the first year in higher education, with particular emphasis on the lack of critical thinking, and numerical and literacy skills among first-year students.

Data collected from the baseline survey, focus-group discussions and semi-structured interviews collectively highlight the low level of preparedness. The findings across these three data sources consistently indicate that first-year students are underprepared upon entry into higher education. The implication of underprepared first-year students entering higher education, particularly in the quantity surveying programme and the building measurement module specifically, underscores the inadequacies of the basic education system in adequately preparing students for higher education. However, it is essential to note that this study does not aim to address the issues at the basic education level. Instead, its focus is on accommodating and supporting underprepared students as they enter higher education.

The second part of the first subsidiary question pertains to the extent of students' prior knowledge upon entry into higher education. Across the various datasets, it is evident that both first-year students and first-year lecturers perceive the lack of prior knowledge as a potential hindrance to effective learning and teaching in the building measurement module. Instances where prior knowledge is assumed by lecturers are noted and acknowledged by students and lecturers. As previously highlighted, prior knowledge is not a prerequisite for entry into the quantity surveying programme or the building measurement module. The quantity surveying programme possesses a degree of uniqueness in that there is no compulsory matric (grade 12) subject directly related to the programme, particularly the core module, the building measurement module. This contrasts with professions such as medicine or accounting, where highly relevant and obligatory matric (grade 12) subjects are required upon programme entry. Consequently, students enter the quantity surveying programme, especially the building measurement module, with limited prior knowledge or experience of the profession's aspects or the measurement module itself. Although prior knowledge is not mandatory, it remains crucial to assess and determine students' existing knowledge levels. This is because new knowledge builds upon prior and existing knowledge and understanding, and determining prior and current knowledge levels is essential for meeting students at their current level of comprehension and understanding. Teaching activities and approaches can then be tailored based on this assessment. The deficiency in prior knowledge is evident, as outlined and analysed in Chapter 5, sections 5.2.5, 5.3.2 and 5.4.2, having an impact on both students and lecturers alike. Chapter 6 further elucidated that while prior knowledge is not a prerequisite, it serves as a foundational element for constructing new knowledge.

Thus, to answer the first subsidiary research question, data obtained from the surveys, the focus-group discussions and the semi-structured interviews show that first-year students entering higher education, specifically the building measurement module, are underprepared and have limited prior knowledge of the subject matter, which contributes to pedagogical challenges in the building measurement module.

7.2.2 What is the <u>nature of the challenges</u> associated with the learning and teaching of first-year quantity surveying students in the building measurement module in South Africa?

The second subsidiary research question investigates the nature of challenges experienced by both students and lecturers at first-year level in the building measurement module. Given the scarcity of literature in this area, it was imperative to incorporate the investigation about the possible challenges into this study. The learning and teaching challenges encountered in the building measurement module at first-year level were primarily investigated and identified through the first methodology which unveiled crucial insights on the challenges that are fundamental to this study.

In terms of the **challenges identified**, four meta-themes emerged from the three data sets gathered in the first methodology, including 1) challenges pertaining to pedagogical difficulties, 2) the learning environment, 3) content or curriculum, and 4) prior knowledge and skills. See section 5.5 and Table 5.10 for detailed description of these challenges.

While there are some similarities to what previous studies have found, as outlined in Chapters 1 and 2, several new challenges were identified and established in the building measurement module at the first-year level. This is largely due to the scarcity of studies focusing on this particular niche area, particularly within the South African context. Some previous studies have investigated pedagogical challenges in the building measurement module, but these were not specifically centred around first-year students. Similarly, there have been studies examining the underpreparedness of first-year students entering higher education, yet few have investigated the specific impact on underprepared first-year quantity surveying students. Therefore, the emergence of pedagogical challenges among underprepared first-year students in the building measurement module in this study significantly contributes to the body of knowledge within the quantity surveying profession. The knowledge gap is illustrated in Chapter 1, Figure 1.1.

The challenges identified in this study related to the learning and teaching in the building measurement module at first-year level are presented in Chapter 5, sections 5.3.4, as well as in section 5.4.4. The majority of challenges identified are consistent across all participating institutions, however, certain institutions reported unique challenges. The unique challenges, such as the utilization of technology and the presence of language barriers, were specific to individual institutions and were not observed in others. Nevertheless, the majority of challenges are experienced uniformly across all participating institutions.

7.2.3 What are the current approaches and techniques used in the learning and teaching of building measurement for first-year quantity surveying students in South Africa?

To address the third subsidiary research question, insights gathered from both the focus-group discussions and lecturer interviews shed light on the prevailing learning and teaching methodologies utilized across the participating institutions. These methodologies exhibit some elements of constructivism, with key features such as active learning, social interaction and the integration of real-world scenarios being central to the learning and teaching process. Data on the current teaching approaches are presented in Chapter 5, section 5.3.3 and section 5.4.3. Lecturers across the institutions employ similar strategies. These similarities encompass a blend of theoretical and practical sessions, characterized by active student involvement and engagement. The evidence indicates that lecturers in the building measurement module prioritize the practical application of content, emphasizing the link between theoretical concepts and real-world scenarios to enhance student understanding. Some instructors favour a constructivist approach, encouraging students to engage actively in creating their own knowledge through hands-on activities and independent exploration. Support structures such as tutor teams are established to aid students with questions or concerns, offering additional resources and guidance as needed. While teaching approaches vary, with some lecturers adapting their pedagogical styles based on observed challenges and others maintaining consistency informed by practical experience, it is evident that all lecturers invest significant time and effort in fostering active engagement and participation among students during lectures. This is a promising finding, as many studies have found that lecturers still rely on traditional teaching techniques (see section 1.3). The seeming willingness of lecturers to try new or alternative approaches to pedagogical practices is a significant first step in advancing learning and teaching in the building measurement module.

In addressing the question regarding the current learning and teaching approaches in the building measurement module, it is apparent that some lecturers incorporate certain aspects of constructivism such as active learning and social interaction into their teaching methodologies. However, it cannot definitively be concluded whether these practices are intentional or not.

7.2.4 What is the perceived effectiveness of the current learning and teaching approaches and of building measurement for first-year quantity surveying students in South Africa?

The fourth subsidiary research question is about the effectiveness of the current learning and teaching approaches outlined in the previous question. It is noteworthy that these methods can be perceived as effective, given the absence of explicit data indicating ineffective practices. While students provided numerous recommendations and areas for improvement, it does not necessarily imply that the current approaches are ineffective. Suggestions and recommendations, as discussed in section 5.3.4, can be considered for implementation to enhance the effectiveness of the learning and teaching methodologies in the building measurement module further. Some of the instructors commented that the high throughput rate of the module is a clear indication of the effectiveness of their teaching approaches. It can be deemed that across the participating institutions the current learning and teaching approach are effective however there are room for improvement.

7.2.5 What facilitation framework towards effective learning and teaching interventions can be applied to bridge the articulation gap of first-year students in order for them to fully grasp and understand the context of the building measurement module?

The findings of this thesis culminate into a proposed facilitation framework to support the incoming first-year student who are underprepared, lack prior knowledge and exhibit an articulation in the building measurement module. It is aimed at supporting lecturers to plan and implement module or unit content appropriately and in line with the constructivist principles of Vygotskian theory. Figure 7.1 illustrates the framework.

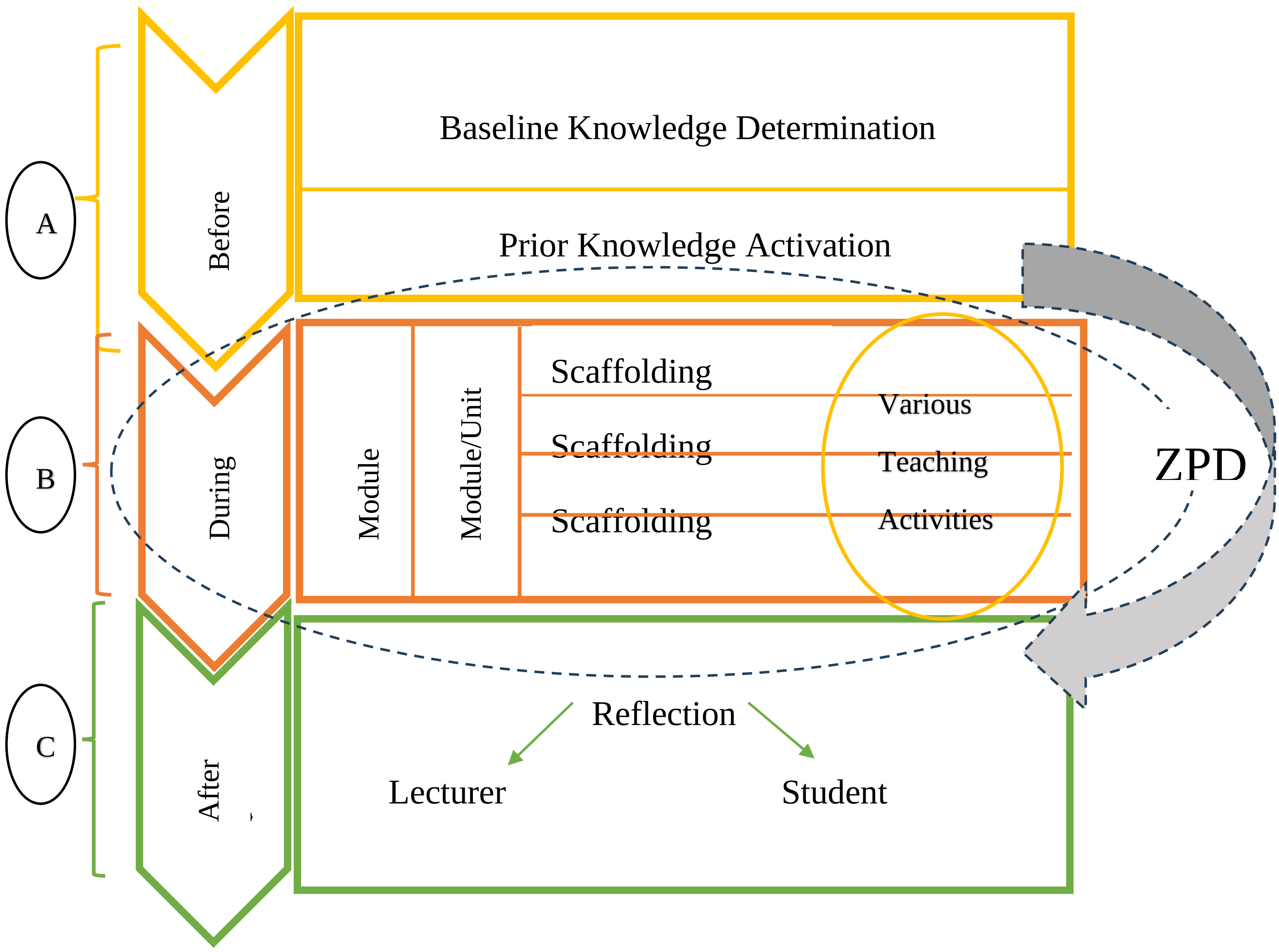


Figure 7.1: Facilitation Framework to enhance learning and teaching in the building measurement module (Created by Author)

Section A of the framework comprises two essential components: baseline knowledge determination and prior knowledge activation. Baseline knowledge determination and prior knowledge activation occur before the start of each unit, theme, chapter of the module. The determination and activation are not once-off activities and should be done at the start of each new unit, as students' knowledge can change at any stage. Therefore, conducting these assessments at the beginning of the year may yield different results compared to continuous assessments throughout the year and before commencing with a new module unit, theme or chapter. As shown in the thesis findings presented in Chapters 5 and 6, determining baseline knowledge is crucial to ensure that students are met at their current level of comprehension and understanding of the subject content. This can be achieved through conducting a short, informal test or activity to assess students' current knowledge levels without it being a formal assessment. Additionally, the activation of prior knowledge is equally vital, as it serves as a starting point for new learning, considering that new knowledge is built upon existing knowledge. Sometimes, it becomes necessary to activate prior knowledge or make students aware of their existing knowledge of the content. Prior knowledge activation can be achieved through various methods, such as showing students pictures and images, telling a story, or referring to their possible prior experiences. For example, one might say,

> *Have you recently seen the new development on Mandela Street, across from the university's main gate? They've cleared the site.*

or,

> *Have you noticed the variety of buildings and structures as you walk around campus?*

These approaches help to engage students by connecting new information to their existing knowledge and experiences. These two activities, baseline knowledge determination and prior knowledge activation, lay the foundation for the lecture and are pivotal in facilitating effective learning.

In **Section B**, during the lecture, students will participate in various scaffolding teaching activities tailored to the module content and module or unit outcomes. These activities encompass a wide range of exercises designed to break down tasks into smaller, more manageable portions for students to master. Scaffolding is temporary by nature and should gradually diminish to enable students to achieve the intended outcomes independently. As students engage with scaffolding activities, they progress through the zone of proximal development wherein the MKO also plays a role. Refer to detail discussion in Chapter 3.

Section C of the framework pertains to activities conducted after the lecture. It is essential for both the lecturer and students to engage in critical self-reflection after each lecture or after the completion of a module unit outcome. Reflection is a fundamental aspect of the constructivist teaching approach and plays a pivotal role in the learning process. Through reflection, valuable insights and information can be obtained, aiding in the consolidation and enhancement of learning outcomes.

In the next section the implications of the implementation of the framework are discussed and presented.

7.3 IMPLICATION FOR FRAMEWORK IMPLEMENTATION

When the implications of the implementation of the facilitation framework are considered, various important thoughts arise:

7.3.1 Implementation framework for achieving module and unit outcomes

The first implication is that this framework can be implemented to achieve either module outcomes or more specific unit outcomes within the module. It can be implemented for the implementation of a module outcome, the various teaching activities needed to achieve these module outcomes can be scaffolded, and the framework can be implemented. For the implementation of the achievement of unit outcomes, the framework would be used to identify scaffolding activities to achieve specific unit outcomes. There is no time limit for its implementation and the framework can be used over a period of several weeks, months or just for one week.

7.3.2 Implementing the framework in large class settings

Although the case-study design was applied in a relatively small class, this framework can also be implemented in a large class setup. There are no limitations or reasons preventing its use in larger classes. For example, the pre- and post-tests can be assessed by students themselves, for instance, by electronic means where students do a poll via WhatsApp or use clickers in the class set-up. The same goes for the post-test. There is no need for the lecturer to attend to each student’s pre- and post-test results. Pre- and post-tests in combination with the activation of prior knowledge serve as an important departure point for students themselves to see their growth, increasing their understanding. Groupwork in large classes is ideal to enhance learning where MKO is present; it leaves the lecturer in a facilitation role and not necessarily in the sole teaching role. MKO within the group can answer questions from other students, which would decrease the individual questions posed to the lecturer. The lecturer, however, should be present and move between the student groups to ensure and facilitate learning. The same apply to the reflection section of the framework, critical self-reflection can assist students greatly in their learning and it is not necessary to be assessed by the lecturer only prompted or guided in the reflection process.

7.3.3 Applicability of the framework across various higher education institutions

The study sample included only universities offering accredited quantity surveying programmes and did not consider universities of technology or other higher education institutions. However, there are no limitations to applying this framework at any higher education institution that offers the building measurement module at first-year level, on NQF level 5.

7.3.4 Applicability of the framework in blended learning scenarios

This framework is also applicable to a blended learning scenario with no limitations or restrictions in its application in this set-up.

Thus the framework for achieving module and unit outcomes is flexible, supporting both broad and specific goals over varied timeframes. While initially tested in small classes, it's suitable for large settings by using self-assessment tools and group work to enhance peer learning. Applicable to any higher education institution, including universities of technology, the framework also adapts easily to blended learning environments without limitations. It is essential to recognize the significance of language in implementing this framework. Language plays a crucial role in the learning and teaching process, and facilitators should remain mindful of language-related issues when applying this framework.

7.4 RESEARCH LIMITATIONS AND RECOMMENDATIONS AND FURTHER RESEARCH

The following limitations and recommendations were observed in this study.

7.4.1 Scope of Study

The scope of this study was limited to South African universities offering fully accredited quantity surveying degree programmes. Consequently, data collection did not include universities of technology and their programmes (refer to Chapter 1, section 1.2 for justification).

7.4.2 Programme Structure

One of the six South African universities offering accredited quantity surveying programmes is unique in that it introduces its building measurement module in the second instead of the first year. As a result, this university was not included in the study, due to not having first-year students in a building measurement module. If second years were involved in this study they will skew the results, because they will have knowledge and experience when they enter the building measurement module in their second year, unlike other institutions where learners fresh out of school enter the building measurement module for the first time.

7.4.3 Participation

One of the universities invited to take part in the study did not participate, leading to a notable reduction in the sample size. While limited participation posed challenges for drawing robust conclusions and may affect the broader applicability of the results, valuable data and insights were successfully gathered from the other four participating institutions.

7.4.4. Mode of Learning

The study specifically targeted full-time, accredited quantity surveying programmes, thereby excluding distance learning, compact, or blended learning modes from consideration. This focus was chosen to provide a clear and focused analysis of the traditional, in-person educational model within the quantity surveying discipline.

7.4.5 Availability of Literature

The study encountered a lack of comprehensive literature on the subject matter, presenting difficulties in contextualizing the research effectively through the literature. This shortage of available resources made it challenging to place the study within the broader academic conversation and utilize established frameworks or theories. Consequently, the study leaned heavily on primary data collection methods and innovative approaches to address these gaps and ensure a thorough analysis of the research problem.

7.4.6 Testing the transferability of the framework

The framework was developed based on the experiences of students and lecturers from different institutions, but could only be tested in an in-depth case study at one institution. It is also recommended that the framework and its transferability potential be tested at other institutions. The case study’s narrow focus and limited sample size restrict the extent to which its findings can be broadly applied. Nonetheless, it is worth noting that while the insights may not be universally applicable, they offer valuable perspectives that can be relevant and transferable to similar contexts. Despite its specific nature, the study provides specific insights that can inform learning and teaching practices in the building measurement module.

It is recommended to apply and test the facilitation framework across a wider audience, including universities of technology and other higher education institutions offering the building measurement module. Further investigations should explore the framework's applicability in various contexts and assess its practical implementation to expand the knowledge base. Additionally, acknowledging that alternative modes of learning may present unique dynamics and outcomes not explored in this study is crucial, suggesting that further research in this area could be beneficial. Finally, it is recommended that more research be conducted on quantity surveying education in South Africa.

7.5 IMPLICATIONS AND KNOWLEDGE CONTRIBUTION OF THIS STUDY ON THE QUANTITY SURVEYING PROFESSION

Through an in-depth investigation into the learning and teaching challenges in the building measurement module for first-year students and lecturers, this research has uncovered unique challenges faced by both groups. By examining these challenges, a better understanding has been achieved, and potential solutions can be explored to enhance the learning and teaching experiences of first year students. It has also been established that a constructivist teaching approach, specifically Vygotsky’s theory of sociocultural development, is a well-suited teaching approach for this module. This insight significantly contributes to the knowledge base of quantity surveying, while these findings provide new perspectives on quantity surveying in higher education.

Furthermore, this research contributes to the body of knowledge of the quantity surveying profession as well as the body of knowledge of higher education. However, due to the knowledge gap in the quantity surveying educational research, this study contributes significantly to this specific body of knowledge. The knowledge gap, as illustrated in Chapter 1, Figure 1.1, lies in the area of research of quantity surveying and higher education. Previously the pedagogical challenges encountered by first-year students and lecturers of the building measurement module were unknown, but now these challenges have been established. Not only has it been established, but possible solutions have been provided, such that the constructivism specifically Vygotsky's theory of sociocultural development has proven to be well suited for the learning and teaching of the building measurement module on first-year level and to overcome some of the pedagogical challenges.

The practical implication of this research is that, following a constructivist teaching approach, universities can enhance the learning and teaching experiences of first-year quantity surveying students by becoming aware of the preparedness and prior knowledge levels of first-year students in the building measurement module and. With an enhanced first-year experience, students have a good foundational knowledge in quantity surveying for the rest of the duration of their studies, which will ultimately contribute to better graduates and professionals. Best practices for teaching the building measurement module on first-year level can also be established from this research through the application and implementation of the suggested framework.

In terms of policy implications, this study might lead to the recommendation of the inclusion of certain matric or Grade 12 subjects to enhance students' prior knowledge and preparedness levels upon entering higher education. Subjects such as Civil Technology and Engineering Graphics and Design might be considered as highly recommended matric or Grade 12 subjects. An introductory class or program in the first year might also contribute to students' preparedness for the building measurement module.

This study can also have an impact on stakeholders such as lecturers and students, as this research provides evidence-based recommendations for improved learning and teaching of the first-year building measurement module. Innovative teaching approaches and active learning can enhance the learning and teaching experiences of first-year quantity surveying students.

7.6 CONCLUSION

In conclusion, this research has provided valuable insights into the learning and teaching challenges faced by first-year students and lecturers in the building measurement module at South African universities. By investigating and uncovering these challenges and identifying the suitability of a constructivist teaching approach, particularly Vygotsky's theory of sociocultural development, this study significantly enhances the knowledge base of quantity surveying education. The findings suggest that adopting a constructivist framework can improve learning and teaching outcomes in this core module. However, the study also identified limitations, such as the need for more extensive testing of the framework in diverse educational settings. Overall, this research contributes to a deeper understanding of educational strategies in quantity surveying and opens up new avenues for enhancing pedagogical practices in higher education.

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APPENDICES

Appendix 1 – Routes to Registration

THE SOUTH AFRICAN COUNCIL
for the
QUANTITY SURVEYING PROFESSION
Established in terms of the Quantity Surveying Profession Act 2000 (Act No 49 of 2000)

Upgrade Route for PrQS Registration

	ACADEMIC		R P L
Programme	SACQSP Accredited Quantity Surveying Degree (BTech / BSc)		Matric + Certificates
Minimum NQF Credit Level	480	360	N / A
SAQA / NQF Exit Level	Level 8	Level 7	N / A
Minimum duration as a registered Construction Quantity Surveyor prior to application	2-Years	2-Years	2-Years
Minimum duration under a PrQS as a Candidate	2-Year	2-Years	2-Years
Additional Professional Skills Modules to be completed	Nil	7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18	7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18
Maximum period as a Candidate to complete professional registration	5-years	5-years	5-years
Compulsory Interim Submission (12-month)	1 off	1 off	1 off
Compulsory Final Submission	Yes	Yes	Yes
Daily Diary	3800 hrs	3800 hrs	3800 hrs
Log Book	Yes 2-yr	Yes 2-yr	Yes 2-yr
General report	Yes 2-yr	Yes 2-yr	Yes 2-yr
Project Specific Report	Yes	Yes	Yes
APC Interview	Yes	Yes	Yes

Appendix 2 – SACQSP Accredited Programmes

Print Page Sign In Register

THE SA COUNCIL FOR THE QUANTITY SURVEYING PROFESSION

Established in terms of the Quantity Surveying Profession Act 2000 (Act No 49 of 2000)

- HOME
- ABOUT US
- REGISTER
- QS RESOURCES
- SKILLS MODULES
- TARIFF OF FEES
- CPD
- ONLINE STORE
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ACCREDITATION OF INSTITUTIONS

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ACCREDITED TERTIARY INSTITUTIONS

The Quantity Surveying / Construction Economics Programmes that are offered at the following institutions have been form

Institution	*Programme*	*Credit / NQF*	*Most recent accreditation inspection*	*Accreditation valid for Graduating*

				Class of...to...
Cape Peninsula University of Technology (CPUT)	National Diploma (Building) Conditional Accreditation	240 / Level 6	2021*	2021-2025
	Diploma in Construction ConditionalAccreditation	360 / Level 6	2021*	2021-2025
	Advanced Diploma in QS ConditionalAccreditation	120 / Level 7	2021*	2021-2025
Central University of Technology (CUT)	**National Diploma (Building)** Full Accreditation	240 / Level 6	2021*	2021-2025
	Bachelor of Construction in QS ConditionalAccreditation	360 / Level 7	2021*	2021-2025
	Post Graduate Diploma in Construction in QS ConditionalAccreditation	178 / Level 8	2021*	2021-2025
Durban University of Technology (DUT)	Bachelor of the Built Environment (BBE)– Construction Studies	240 / Level 7	2022*	2023-2027
	BBE Honours in QS Conditional Accreditation	**360 / Level 8**	**2022**	2023-2027
Mangosuthu University of Technology (MUT)	**National Diploma (Building)** **Not Accredited**	**240 / Level 6**	**2017***	
Tshwane University of Technology (TUT)	**National Diploma (Building)** ConditionalAccreditation	240 / Level 6	2018*	2018-2022
	Diploma in Building ConditionalAccreditation	240 / Level 6	2018*	2018-2022
Walter Sisulu University of Technology (WSU)	**National Diploma (Building)** Conditional Accreditation	**240 /Level 6**	**2018***	2023-2027
University of Johannesburg (UJ)	BSc Construction Studies ProvisionalAccreditation	360 / Level 7	2021*	2021-2025
	BSc Honours QS ProvisionalAccreditation	480 / Level 8	2021*	2021-2025
University of the Witwatersrand (WITS)	**BSc Quantity Surveying** Full Accreditation	360 / Level 7	2022	2023-2027
	BSc Quantity Surveying Honours Full Accreditation	480 / Level 8	2022	2023-2027
	BSc Construction Studies Full Accreditation	360 / Level 7	2022	2023-2027
University of Cape Town (UCT)	**BSc Construction Studies** Full Accreditation	360 / Level 7	2022	2023-2027

	BSc Honours QS Full Accreditation	480 / Level 8	2022	2023-2027
University of the Free State (UFS)	**BSc Quantity Surveying** FullAccreditation	360 / Level 7	2022*	2023-2027
	BSc Quantity Surveying Honours FullAccreditation	480 / Level 8	2022*	2023-2027
University of Pretoria (UP)	**BSc Quantity Surveying** Full Accreditation	360 / Level 7	2023	2024-2028
	BSc Quantity Surveying Honours Full Accreditation	480 / Level 8	2023	2024-2028
Nelson Mandela University (NMU)	**National Diploma (Building)** Full Accreditation	240 / Level 6	2023*	2023-2027
	Advanced Diploma Quantity Surveying Full Accreditation	120 / Level 7	2023*	2023-2027
	BSc Construction Economics Full Accreditation	360 / Level 7	2022	2023-2027
	BSc Quantity Surveying Honours Full Accreditation	480 /Level 8	2022	2023-2027

* **Conditional accreditation** – conditions to be met within 12 months.
# Programme phased out/discontinued.
Intec college QS programmes are not accredited by the SACQSP.

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Appendix 3 – RICS Accredited Programmes

RICS ACCREDITED DEGREES. FIND THE RIGHT COURSE FOR YOU.

Search:

#	Course	University	Study mode	Level
1	BSc Hons - Quantity Surveying	University of Cape Town	Full Time	Undergraduate Degree
2	BSc Hons - Quantity Surveying	University of the Witwatersrand	Full Time	Undergraduate Degree
3	BSc Hons - Construction Management	University of the Witwatersrand	Full Time	Undergraduate Degree
4	BSc Hons - Construction Management	University of Cape Town	Full Time	Undergraduate Degree
5	BSc Hons - Construction Management	University of the Free State	Full Time	Undergraduate Degree
6	BSc Hons - Quantity Surveying	University of the Free State	Full Time	Undergraduate Degree
7	BSc Hons - Quantity Surveying	Nelson Mandela University	Full Time	Undergraduate Degree
8	BSc Hons - Quantity Surveying	University of Pretoria	Full Time	Undergraduate Degree
9	BSc Hons - Construction Management	University of Pretoria	Full Time	Undergraduate Degree

https://www.ricscourses.org/

Appendix 4 – Summary of Pedagogical Challenges

Author(s)	Pedagogical Challenges	Possible Solutions and Teaching Alternatives
Wong, Oladinrin, Ho, Guilbert & Kam (2022) Hong Kong	Investigated an e-learning approach in construction measurement in Hong Kong,	A blended learning approach is recommended for the measurement module.
Tunji-Olayeni, Kajimo-Shakantu, Ayodele & Emmanuela (2021) Nigeria	In civil engineering measurement in Nigeria the five most significant **learning challenges** were identified as: 1) lecturer's speed, 2) measurement process, 3) measurement calculations, 4) understanding SMM and 5) taking off sheet.	Authors **propose** lecturers of civil engineering adapt their teaching style, and maybe follow a slower pace.
Ekundayo, Shelbourn & Babatunde (2021) UK	Constructivism in QS education is **supported** by the authors in research done in UK	A constructivist learner-centred approach is suggested with a multi-disciplinary approach.
Gurmu, Kamardeen & Mahmood (2021) Australia	The authors investigated a blended pedagogical model for effective teaching in the building measurement module in Australia as students have shown low grades (**challenges**) over the past few years in this module compared to other modules. Students have difficulty interpreting building measurement concepts and procedures. Lack of building technology knowledge, inadequate learning resources, and less interactive teaching methods.	The authors suggest the delivery strategy, lecturers' characteristics, and assessment is pedagogical tenets that should also be investigated. There is still a knowledge gap in developing a comprehensive pedagogical model to address learning challenges in the building measurement module.
Kibwami, Wesonga, Manga & Mukasa (2021) Uganda	The authors conducted research in Uganda, with regards to quantity surveying education and the improvement thereof. Authors found there exists a mismatch between industry practitioners, professional bodies and tertiary	It is **suggested** that students have regular site visits, work placements and more on-site training opportunities. Thus more industry exposure as well as the adoption of a problem-solving teaching approach.

	institutions expectations and alignment.	
Mojtahedi, Kamardeen, Rahmat & Ryan (2020) Australia	Flipped classroom and active learning for construction education are investigated	Flipped classroom and active learning are **suggested** in Australia to enhance student learning in construction education.
Gurmu & Mahmood (2020) Australia	Authors investigate challenges at an Australian university and found the following learning difficulties and challenges over a five year period for the building measurement module. 1) Difficulty in managing group assignments, 2) inadequate knowledge of mathematics and construction technology, 3) lack of sufficient time to practice seminar questions, 4) the inflexibility of the class and seminar timetables.	Timetables can be adjusted.
Farrow & Wetzel (2020) USA	Authors refer to the 'stand and deliver' lecture which is still being used and although still widely prevalent in higher education this method of delivery has been accepted among educators as one of the more ineffective approaches to foster cognition and retention.	Research has shown students prefer active, participatory, and experiential learning. Thus active pedagogy is **promoted** in construction management education.
Paul, Jatau & Zaki (2019) Nigeria	The continuous decline in students' academic performance in QS-related courses in Nigeria. Investigation of QS students' performance in Nigeria. Several factors were discovered to affect student performance. Gender, age and interest have an impact on performance	
Suhaida, Nurul, Razak &	There is a growing need for universities to provide their QS	Thus to realise the full potential of such new skills a parallel shift is required in

Shazwan (2019) Malaysia	graduates with appropriate BIM related skills. Students need to fit the changing industry.	the teaching approaches because it desired the concepts such as collaboration and integration in Malaysia. A cross disciplinary or multi-disciplinary modules in the most implemented approach in BIM teaching and learning.
Senaratne & Rodrigo (2019) Australia	The use of software in building measurement education. The traditional taking-off format has been used for decades. The transition from the traditional manual measurement process to a computer-aided measurement process was elaborated on.	By introducing a new simpler format because the traditional method of teaching is considered to be tedious. New simpler ways of measuring were introduced (the horizontal layout) positive feedback for staff and students.
Mohamed, Islam, Yusof, Misnan, Othman & Ramly (2018) Malaysia	The Malaysian built environment educational framework went through a philosophical shift from a behaviourist to a constructivist framework due to transformation in QS teaching methodology, learning environment and technological innovation.	
Zulu, Haupt & Tramontin (2018) South Africa	Zulu, Haupt & Tramontin (2018) refer to the scaffolding of complex problems and tasks of construction-related disciplines. They also refer to constructivism as a widely accepted teaching and learning approach due to its efficacy of being student-centered. Constructivism is also active learning.	Constructivism approaches include inquiry-based learning, problem-based learning, project-based learning, studio-based learning, case-based learning, discovery learning, and action learning. All these approaches are based on students learning while working on proposing a solution to a problem.
Ayinde & Samuel (2018) Nigeria		"Building Construction courses should be a pre-requisite for Building Measurement courses since Building Construction courses provide the theoretical and practical background for Construction Measurement courses so as to enhance student' performance:. Authors have proposed that building construction courses should be a pre-requisite for building measurement

		module to improve performance of student in building measurement module. Building construction courses provide the theoretical and practical background for construction measurement courses
Hefer, Fester, Zulu & Haupt (2016) South AFrica	Constructivism in architecture education in South Africa . Studio based teaching approach in architecture is similar to teaching approaches found under constructivist learning models which are characterised by students' active participation to construct knowledge. Traditional lecture approaches are strongly instructive in nature to improve the learning experience.	Authors are supportive of constructivism in construction education more specifically in architecture in South Africa.
Tunji-Olayeni, Amusan, Omuh, Afolabi, Ojelabi (2016) Nigeria	Learning difficulties have been identified in the building measurement module in Nigeria. Their research identified three sources of learning difficulties in the building measurement module: 1) the lecturer, 2) the lecture, 3) the learning facilities. The teaching styles of lecturers made comprehension difficult, lecturers rushed through the work and assumed students possess knowledge already. Lectures are non-interactive and examples are insufficient and not illustrative enough for students to understand fully. Lack of exposure to software and indigenous textbooks on building measurement were identified as the learning facility source the of difficulty.	Recommendations include: sites visits, sufficient examples, reference to indigenous textbooks, interactive teaching sessions and use of 3D drawings and videos.

Sunindijo, (2016) Australia		New teaching and learning approaches have been proposed in first-year construction management education such as - Deep learning, flipped classrooms and learner-centered approaches to improve the learning experience of students. Due to the practical nature of the construction industry, the value of real-life projects or cases as examples or site visits should be included in the course. Research done is Australia.
Smallwood & Cumberlege (2016) South Africa	The teaching methodology of the quantities module went through transformation and re-configuration over the last couple of years to make the presentation of the module as well as the module content more comprehensible for the students.	In their research Smallwood & Cumberlege make mention of Piaget (1950): He (Piaget) *is of the opinion that individuals construct new knowledge through processes of accommodation and assimilation from their experiences, thereby incorporating new experiences into and already existing framework without changing the framework*
Goedert & Rokooei (2016) USA	Traditional lectures must be reviewed in construction engineering education	Traditional lectures in construction education must be reviewed and complex problems should be introduced through scaffolding. The project-based approach was used to overcome the challenges of entry-level construction students in construction education at Nebraska-Lincoln university, USA. Homebuilding industry.
Harinarain & Haupt (2015) South Africa	Construction education needs to be revised to enable graduates to enter the increasingly complex and demanding work environment.	In construction education in South Africa, an introduction of studio-based learning was proposed and implemented to embrace an active learning pedagogy.
Lee (2013) UK	Assessment of the efficiency of video and interactive PowerPoint	Active class activities such as discussions, questions, arguing,

	as tools to assist the delivery of the measurement module and to support student learning. (first and second years) First-year students are not equipped with skills to read construction drawings, let alone able to measure accurately and note the measurements down in a set format. *"Students in their first year are not equipped with the skills to interpret construction drawings, let alone able to accurately measure, and note the measurements down in a set format. Additionally teaching students to read and interpret anatomical construction drawings of building structures in 2D and then visualize it in 3D can be a difficult task for the lecturer". Measurement is an important skill that a QS should have it is imperative that students acquire this skill.* (Lee, 2013).	brainstorming and reflections are encouraged. Author suggests an interactive teaching approach to quantity surveying measurement. The use of powerpoint as a visual tool to present anatomic information Powerpoint helped students to understand the module better. It helped with 3D visualization, made the delivery of module better, PP enriched students learning experience. However it did not helped them to understand building construction drawings better. Lee also indicates that the measurement module falls under the cognitivist and constructivist orientation because students need to develop capacity and skills to learn better and to construct knowledge.
Nompunga (2013) South Africa	Challenges and change in construction engineering teaching in South Africa. Nompunga (2013) refers to Dewey's concept of seeing *"Teachers as learners", "teachers as researchers" and teachers as practitioners"* in a research study on engineering education.	The findings of this research have indicated that engineering education should move away from conventional teacher-centered teaching to a student-centered teaching approach.
Glick, Porter, & Smith (2012) USA	Authors state that both the teaching and the learning of construction management education in USA remain a challenge specifically for incoming undergraduates. *"Students coming into CM typically do not have an extensive background in the field and sometimes struggle in core content courses like construction materials*	It is proposed that 3D models be used to assist in the teaching and learning of construction management education.

	and methods, plan reading and estimating".	
Ostrowski (2011) UK	The provision of QS teaching as technical competence in universities has been affected by the lack of a pedagogical foundation, increased student numbers and a greater diversity of students. There is very little research on the principles of teaching QS. The measurement process, calculations, technology, SMM and rulings as well as speed were key pedagogical difficulties found in measurement in quantity surveying in the UK. The process, calculations, technology, SMM and rulings and speed The provision of QS teaching as technical competence in universities has been affected by the lack of a pedagogical foundation, increased student numbers and a greater diversity of students. There is very little research on the principles of teaching QS. Published work in mainly concerned with the impact of various teaching programmes and empirical reviews of numbers of students involve.	Need to use the correct teaching despite increasing restrictions on resources, space and time. Proposed a cognitive framework for development. Coherent framework of pedagogy for QS work and enables the appropriate pedagogical modifications to current teaching practice for the difficulties that have been identified. Epistemological, cognitive, psychological, environmental, emotional.
McDonnell (2010) Ireland	Many students find the building measurement module a challenge especially in the first semester of their first year due to adapting to a new stage of their life. Lecturers favour the traditional teaching approach which includes traditional manual measurement techniques. The efficacy of this	From a personal perspective, McDonnell (2010) adds: *"I am constantly investigating new approaches to teaching measurement".* Students prefer the traditional manual measurement techniques, but with better access to measurement software.

	manual method is questioned due to the computerised work environment. Research was done in Ireland during an investigation about the relevance of the traditional teaching approach in the measurement module to undergraduate QS students. *"Although manual measurement is no longer used from a commercial point of view in the workplace, its value as a learning tool should not be underestimated"* (McDonnell, 2010). Many students find the building measurement module a challenge especially in their first semester of their first year due to adapting to new stage of their life. Lecturers favour the **traditional teaching approach** which include traditional manual measurement techniques. The efficacy of this manual method is questioned due to the computerised work environment. Is the practice of teaching traditional manual measurement an outdated and redundant modus operadi? Also mention the inter-relationship between construction technology and the measurement module. The delivery of the measurement module can't be in isolation.	Students learn by doing. Shared learning experiences. Students make sense of what they already know. Manual measurement carried out in small tutorial groups enhances these vehicles of learning whereas the use of measurement software packages would not. Manual measurement should be retained in the teaching approach and must be supplemented with and not replaced by software packages.
Liu, Hodgson,. & Lord (2010) UK	E-learning aims to improve QS students understanding of drawings through the use of various 3D models. E-learning complement traditional learning approaches, maintain student's interest and reinforces understanding.	Social constructivism as an explanatory theory for online learning effectiveness enables learners to actively construct their own perspectives.

Hartmann, Doree & Martin (2010) South Africa	Hartmann, Doree and Martin (2010) consider construction management to be a *"discipline that requires students to solve social technical problems by collaboratively engaging in a social proves of knowledge production and sense-making. That is in line with the constructivist view of learning"*.	*Constructivism is advocated for in south African construction management education.* The authors consider CM to be a discipline that requires student to solve social technical problems by collaboratively engaging in a social proves of knowledge production and sense making. That is in line with the constructivist view of learning
Haupt (2009) South Africa	The standard of secondary education and the entry-level quality of students were poor as per a report compiled in 2009 on education and training issues in the South African construction industry.	
Verster & Hauptfleisch (2009) South Africa	Challenges and change. QS firms are ready to meet the challenges of changing environments of standards, education, professional development, and training. Authors investigated maturity in the quantity surveying profession	It is advised that attitude toward development and growth is vital for the future survival of the profession of QS in South Africa. Authors propose a more practical approach towards education for construction professions due to the changing professional environment
Leung & Chen (2008) Hong Kong	Learning approaches and teaching orientations must be evaluated. Research report of the Institute of QS in Hong Kong. The quality of QS university graduates is still criticised by educators, senior governmental officials and by industrial employers.	Alternative teaching approaches are recommended and should be students centred and include activities such as problem based assignments, project-based exercises and site visits and group discussions. This research was done as part of the advancement of performance of QS students in Hong Kong. Alternative teaching methods which are student centred teaching are recommended for QS education, PBL and site visits are recommended

		Student centred teaching approach and a deep learning approach were popular among teachers and students
Hodgson, Sher & Mak (2008) UK	Students need to have an understanding and knowledge of construction technology to enable them to measure and be successful in the measurement module. This is a challenge for lecturers. When students are required to learn how to measure they do not have the underpinning and previous knowledge and understanding of construction technology. Students need to have an understanding and knowledge of construction technology to enable them to measure. This is a challenge for lecturers. When students are required to learn how to measure they do not have the underpinning and previous knowledge and understanding of construction technology. Students need to understand the technology in order to apply the rules of standard method of measurement. Traditional teaching approach separate construction technology and measurement. This is frustrating for students and hinder their learning.	Students need to understand the technology in order to apply the rules of the standard method of measurement. The traditional teaching approach separates construction technology and measurement. This is frustrating for students and hinders their learning. e-learning approach Problem based learning approach (PBL), online measurement tutorials. Different teaching approach which involve the use of technology. (image capture software and 3D modelling) Blended teaching approach.
Hasan & Rashid (2005) Malaysia	The conventional teaching approach was found to be ineffective to teach key knowledge and skills in taking off (building measurement module). Particular challenges include a lack of understanding of construction technology, and concepts of measurement as well as a lack of skills required in taking off. There is fragmentation of the teaching of construction technology,	and suggested a measurement studio as part of innovation in teaching building quantities module in Malaysia. Non-conventional and fully integrated 5 dimensional studio approach was suggested for measurement courses. Integration of 5 elements of theories and practice in measurement of construction work. 1) Theories in construction technology, principles of measurement

	measurement principles and the measurement exercises. The lack of coordination in drawings used for measurement lectures, exercises and coursework seem to be a problem as authors investigate innovative teaching techniques in QS education Conventional approach of lectures, tutorials manual taking off exercises and taking off examples using computers. This approach was found to be ineffective to teach key knowledge and skills in taking off. Particular challenges include lack of understanding in construction technology, concepts of measurement as well as lack of skills required in taking off. The delivery approach seem to be the problem because it seems to be fragmented and uncoordinated. There is fragmentation of the teaching of construction technology, measurement principles and the measurement exercises. The lack of coordination in drawings used for measurement lectures, exercises and course-work. Alternative approaches in the delivery of the measurement of construction works courses were considered.	and mathematics, 2) skills in taking off quantities, 3) practice in preparing and presenting BoQ, 4) application of ICT and 5) assessment of students' output. Main objective was to minimise fragmentation, a flaw of the conventional approach.
Christodoulou (2004)	Academicians and practitioners alike are increasingly aware of and concerned for, the unprecedented changes and challenges of current engineering practice, and recognizing that traditional engineering education is faced with great challenges and opportunities.	and recognizing that traditional engineering education is faced with great challenges and opportunities. Transfusion of information technology and process automation concepts through necessary reorganization of classes and curricula. Fully integrated automated project processes.

Murry, Donohoe & Goodhew (2004) UK	Teaching methods in universities need to change with a strong emphasis on independent and autonomous learning. Recognising the need for change in higher education. Research in UK was undertaken to improve student learning in the building and civil engineering disciplines (construction education).	through a concept called-student-centered flexible learning. This was an evolutionary rather than a revolutionary approach where lecturers innovate and experiment with their teaching methods to the benefit of their students. The teaching approach included: self-learning packages, self-guided field trips, e-learning packages, student-led projects, seminars, workbooks and coursework assignments
Chan, Chan, Scott & Chan (2002)	to enhance the innovativeness, creativity, and curiosity of students.	It is important that academia adopt modern and innovative ways of teaching for construction professionals and a student-centered and project-based learning environment
Fortune & Skitmore (1994) UK	Concerned about the acquisition of quantification skills in formal education writing from the UK	and it is recommended to move away from the formal lecture and practice session toward a workshop environment. Quantification skills may be better developed by changing the emphasis in the **delivery** of quantification studies within courses of higher education away from formal lecture and practice session towards a strategy which sets up a framework for learning opportunities in a workshop environment that develops problem solving abilities, utilising numeracy, communication and organisational skills. Workshop environment.

Appendix 5 – PQS Profile Table Summary

Table 2.6: Summary of Professional Quantity Surveyor Profile

	Identification of Work	Services & Responsibilities	Competencies	Competencies	Skills Required	Workplace Skill and Experience	Attributes
	SACQSP Identification of Work document, Aug 2011	**Literature Review**	**SACQSP Identification of Work Document, Aug 2011**	**RICS Pathway Guide, Aug 2018**	**Literature Review**	**SACQSP Registration Policy, March 2015**	**Literature Review**
1	Interaction with stakeholders	Advice on: Costs, estimating, property development, tender procedures and contractual arrangements	**Undertake descriptive** quantification	CORE:	Able to manage cost effectively	Develop project briefs and attending project initiation meetings	High level of professionalism
2	Interpreting construction drawings and specifications	Tender evaluation and reports	Undertake budgetary reporting	Commercial management of construction works	Financial skills	Procurement advice	Risk taker
3	Compilation of price determination documents	Contract administration	Prepare cost estimates	Construction technology and environmental services	Analytical skills	Defining the quantity surveyors scope of work and services and finalising the service agreement (QS and client)	Innovative
4	Taking off quantities and prepare price determination documents for simple and complex buildings	Project procurement	Prepare for and implement cost planning and cost monitoring processes	Contract Practice	Interpretive skills	Advising on economic factors affecting the project and on appropriate financial design criteria	Fast thinker
5	Implementing budgetary processes	Prepare Bill of Quantities	Provide procurement advice	Procurement and tendering	Teamwork skills	Agreeing the documentation programme for the project	Ambitious
6	Cash flow forecasting and management	Cost management	Managing of payment processes	Project finance (cost and reporting)	Communication skills	Review and evaluate design concepts - value engineering	Work under pressure
7	Prepare financial reports	Financial control	Manage the effect of scope changes	Quantification and costing of construction work	Decision making skills	Prepare estimates	Systematic and orderly mind
8	Prepare cost estimates	Cost control, planning and reporting	**Determine** resource requirements	MANDATORY:	Contractual and legal skills	Financial viability reports and feasibility studies	
9	Advice on design-cost alternatives	Calculation of price fluctuations	Apply legal principles	Ethics, rules of conduct and professionalism	Must write neatly and work tidy	**Auditing space allocations** against the initial brief	**Older sources:**

10	Undertake project cost norm analyses	Cash flows	Strategic planning	Client care	Must be accurate and careful in calculations	Review documentation programme	Tact
11	Prepare replacement cost valuations	Budgets and cost estimates	Provide advice on contract documents and price determination methods	Communication and negotiation	Be able to visualize drawings and detail	Review and evaluate design and outline specifications and exercising cost control	Patience
12	Cost planning and cost control	Valuation of work in progress	Manage production processes of price determination documents	Health and Safety	Negotiation skills	Prepare detailed estimates	Accuracy
13	Providing procurement advice	Monthly payment valuations, certificates and progress payments	Resolve claims, settle disputes and apply close-out procedures	Accounting principles and procedures	Knowledge of drawings, details, materials and construction	Review financial viability report	Energy
14	Management of payment processes	Final accounts	Implement project service quality assurance	Business Planning	Good organisational abilities	Prepare area schedules and advising on space and accommodation allowances	Common sense
15	Identify and management of scope changes	Quantification of construction work	Undertake financial feasibility studies	Conflict avoidance, management and dispute resolutions procedures		Advising on escalation formulae and their implementation	Curiosity
16	Determination of resource required	Estimate value of variations	Compile a project cost information database	Data management		Formulation of procurement strategy for contractors, sub contractors and suppliers	Confidence
17	Contractual management	Measurement of variations	Manage price determination processes	Diversity, inclusion and teamworking		Review working drawings for compliance with the approved budget for construction cost and or financial viability	Intuition
18	Undertake strategic planning	Feasibility studies	Manage risk	Inclusive environments		Prepare procurement documentation including measurement and design of work, drat of preliminaries, preambles and	

						contract conditions	
19	Cost and benefit analyses	Asset financial management	Undertake whole life appraisal	Sustainability		Taking off quantities and preparing price determination documents	
20	Economic and financial analyses	Investment appraisals	**Understand** the principles of sustainability assessment	OPTIONAL:		Advice on tender selection	
21	Contract documentation advice	Act in disputes	Understand value management processes	Capital allowance		Calling of tenders and negotiation of prices	
22	Advice on price determination methods	Construction project management	Design and implement specialised quality assurance procedures	Corporate recovery and insolvency		Evaluation and reporting on tenders	
23	Manage the production and preparation of price determination documentation and cost management documents	Negotiate rates with contractors	Conduct tax assessments	Due diligence		Preparing contract documentation	
24	Resolve claims		Conduct land and related tax assessments	Insurance		Advising on the different forms of construction contracts	
25	Prepare final accounts		Conduct specialised audits	Programming and planning		Prepare health and safety requirements for project	
26	Apply close-out procedures		Understand professional practice management procedures in a qs enterprise	Project feasability analysis		Attend site handover, site, technical and progress meetings	
27	Develop and implement project service quality assurance procedures			Risk management		Prepare schedules of predicated cash flow	
28	Undertake financial feasibility studies including market need,			Contract Administration		Cost control during progress of work including advise on proposed variations and	

	risk and return analyses					on alternative construction methods and sequencing.	
29	Planning and managing environmental initiatives					Reporting on cost variations and contractual issues	
30	Managing and administering construction projects on site					Adjudication and resolving financial claims by the contractor, sub contractors or suppliers	
31	Managing construction organisational assets					Prepare valuations for interim payment certificates and reconciliation statements	
32	Design, compile and utilization of project cost information databases					Measuring and recording site information for final account purposes	
33	Managing the price determination, awarding and evaluation processes (tender process management)					Preparing and agreeing final accounts	
34	Risk management					Preparing valuation for final payment certificates and reconciliation statements	
35	Undertake whole life appraisals					Preparing fee accounts based on appropriate fee scale and conditions of appointment	
36	Contribute to the sustainability assessment					Specialisation:	
37	Undertake value management exercises					Project planning and management	
38	Design and implement specialised service quality					Dilapidations and maintenance	

	assurance procedures						
39	Conduct tax assessments					Office management, resource allocation and budgeting	
40	Conduct land and related tax assessments					Taxations allowance and grants	
41	Conduct premises, energy, maintenance and assets register audits					Insurance	
42	Undertake professional practice management including structuring the enterprise, negotiating qs-client agreements and applying relevant fee scales					Litigation, arbitration, liquidation and insolvency	

From the table above it is evident that there are multiple and various important roles and responsibilities of the professional quantity surveyor and to execute these roles successfully, the quantity surveyor needs to have certain and specific corresponding competencies, skills and attributes also demonstrated in the table. One of the most imperative skills a quantity surveyor needs is quantification or measurement skills to successfully fulfil their duties.

Appendix 6 – Ethics Letter UFS

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

12-Sep-2022

Dear Mrs Mart-Mari Els

Application Approved

Research Project Title:

Towards a Facilitation Framework for Effective Learning and Teaching for First Year Students in the Building Measurement Module.

Ethical Clearance number: **UFS-HSD2022/0867/22**

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

Dr Adri Du Plessis

Chairperson: General/Human Research Ethics Committee

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Park West Bloemfontein 9301 South Africa
P.O. Box 339 Bloemfontein 9300
Tel: +27 (0)51 401 9337 duplessisA@ufs.ac.za **www.ufs.ac.za**

Appendix 7 – Ethics Letter UJ

20 January 2023

Mart-Mari Els
University of the Free State (UFS)

Dear Mart-Mari Els

PERMISSION TO CONDUCT RESEARCH AT THE UNIVERSITY OF JOHANNESBURG

The request for the project titled *Towards a Facilitation Framework for Effective Learning and Teaching for First Year Students in the Building Measurement Module* refers. Permission is granted to conduct this study at the University of Johannesburg (UJ).

Please note that the granting permission does not make it mandatory for UJ students and/or staff to participate in the study. As the researcher/applicant, you will need to engage with potential participants to obtain their consent to participate in the study.

Should you require assistance in distributing the survey to UJ students and/or staff, kindly send a brief description of your study together with the link to where participants can access the survey to tdewet@uj.ac.za, copying hemalij@uj.ac.za and rloots@uj.ac.za.

Sincerely

Dr Ndivhuwo Luruli
Executive Director: Research and Innovation
Email: nmluruli@uj.ac.za

Cnr Kingsway and University Road Auckland Park • PO Box 524 Auckland Park 2006 • +27 11 559 2911 • uj.ac.za
Auckland Park Bunting Campus • Auckland Park Campus • Doornfontein Campus • Soweto Campus

Appendix 8 – Ethics Letter WITS

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

OFFICE OF THE DEPUTY REGISTRAR

24 January 2023

Mart-Mari Els
Doctor of Philosophy
University of the Free State

TO WHOM IT MAY CONCERN

"Towards a Facilitation Framework for Effective Learning and Teaching for First Year Students in the Building Measurement Module."

This letter serves to confirm that the above project has received permission to be conducted on University premises, and/or involving staff and/or students of the University as research participants. In undertaking this research, you agree to abide by all University regulations for conducting research on campus and to respect participants' rights to withdraw from participation at any time.

If you are conducting research on certain student cohorts, year groups or courses within specific Schools and within the teaching term, permission must be sought from Heads of School or individual academics.

Ethical clearance has been obtained. (Protocol number: UFS-HSD2022/0867/22)

Research Expiration: (12 September 2023)

M Potgieter

Nicoleen Potgieter
University Deputy Registrar

Private Bag 3, WITS, 2050, South Africa | T +27 11 717 1204/9 | E nicoleen.potgieter@wits.ac.za | www.wits.ac.za

Appendix 9 – Ethics Letter UP

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Office of the Registrar

2022-12-01

Ms M Els
Higher Education Studies
Faculty of Education
University of the Free State
South Africa

Email: ArcherM@ufs.ac.za

Dear Ms Els

APPROVAL OF RESEARCH STUDY

The UP Survey Coordinating Committee has granted approval for the research study titled "Towards a Facilitation Framework for Effective Learning and Teaching for First Year Students in the Building Measurement Module".

The proposed research study has to strictly adhere to the associated study protocol, as well as the UP Survey Policy and the Ethics Committee of the Faculty of Humanities instructions.

Please liaise with the Market Research Office in the Department of Institutional Planning (carlien.nell@up.ac.za) to officially register the study and to finalise the survey regulations, procedures and the fieldwork dates. In order to register the study, the Market Research Office has to receive the formal ethical approval letter from the Faculty of Humanities.

A final electronic copy of the research outcomes must be submitted to the Survey Coordinating Committee as soon as possible after the completion of the study.

Kind regards

Prof CMA Nicholson
REGISTRAR
CHAIRPERSON: SURVEY COORDINATING COMMITTEE

Rectorate, Room 4-23, 4th floor, Administration Building, Hatfield Campus
University of Pretoria, Private Bag X20
Hatfield 0028, South Africa
Tel: +27 (0)12 420 4236
Fax: +27 (0)12 420 5849
Email: regis@up.ac.za
www.up.ac.za

Kantoor van die Registrateur
Ofisi ya Mmušakarolo

Appendix 10 – Ethics Letter NMU

NELSON MANDELA UNIVERSITY

PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa mandela.ac.za

Chairperson: Research Ethics Committee (Human)

Tel: +27 (0)41 504 3624

Dalray.Gradidge@mandela.ac.za

NHREC registration nr: REC-042508-025

Ref: [H23-ENG-BQS-EAP-001] / Approval: 2927 March 2023 – 29 March 2024

29 March 2023

Dear Dr Loots

TOWARDS A FACILITATION FRAMEWORK FOR EFFECTIVE LEARNING AND TEACHING FOR FIRST YEAR STUDENTS IN THE BUILDING MEASUREMENT MODULE

PRP: Dr S Loots

PI: Ms M Els

Your application for ethics approval to conduct research at Nelson Mandela University has been considered by the REC-H on the basis that the study has been duly vetted and approved by the University of the Free State, Research Ethics Committee.

Kindly use the following ethics reference number **H23-ENG-BQS-EAP-001** together with your University's ethics clearance number in any correspondence with gatekeepers and participants at the University. Ethics clearance is valid for one year.

Please inform the REC-H, of any changes that may arise during the execution of the study, particularly to the methodology.

It must be noted that the Nelson Mandela University assumes that the Research Ethics Committee responsible for providing the original ethics approval/clearance has undertaken both ethics and scientific review of the protocol according to the National Health Research Ethics Committee (2015) Guidelines, and assumes primary responsibility for oversight with regard to any ethical issues that may arise in the course of the study. The Nelson Mandela University would also wish to be provided with an executive summary of the findings from the research.

We wish you well with the project.

Yours sincerely

Dr D Gradidge Chairperson: Research Ethics Committee (Human)

cc: Department of Research Development

Appendix 11 – Baseline Survey

Descriptive Quantification

FIRST YEAR STUDENTS

2022

Towards a Facilitation Framework for Effective Learning and Teaching for First Year Students in the Building Measurement Module.

Baseline Survey

Please complete the survey below.

1.	Age	18 19 20 21 22 Other, please specify
2.	Male/Female/Other	
3.	Year of matriculation	2017 2018 2019 2020 2021 2022 Other, please specify
4.	If you did not matriculate in 2022, what did you do prior to 2022?	
5.	Do you hold any prior qualification/diploma/degree other than matric?	YES / NO
6.	If yes, please specify	
7.	Were you **enrolled** for a programme / qualification prior to enrolment for Quantity Surveying?	YES / NO
8.	If yes, please specify the qualification	
9.	Please select your matric subjects from the list.	English Afrikaans Mathematics Physical Science Life Science Economics Accounting Business Economics

Page 1 of 4

		Technical Drawing Civil Technology Information Technology Computer application technology Engineering Graphics and design Business Studies Geography Life Orientation Other, please specify
10.	On a scale of 1 – 10 how prepared / ready do you feel to enter university?	Least prepared Most prepared 1 2 3 4 5 6 7 8 9 10
11.	Please motivate your answer given for the above question?	
12.	Which of the matric subjects listed in question number 9 above do you think will benefit you in your quantity surveying studies? Please also explain how you think they will benefit you.	
13.	How did you decide to study quantity surveying?	
14.	When you applied for quantity surveying, what did you think it was all about?	
15.	Has your opinion changed since then? If yes, please explain how it has changed and why.	
16.	Do you have any prior knowledge, experience or exposure to the construction industry in general? (e.g holiday work, shadowing etc).	YES / NO
17.	If yes, please specify what experience or exposure you have had in the **construction industry**	
18.	Do you have any prior experience or exposure to the **profession of quantity surveying?** (e.g holiday work, shadowing etc).	YES / NO
19.	If yes, please specify what experience or exposure you have had in the **quantity surveying profession**	
20.	Do you have any prior experience or exposure to a **scale ruler** or to read and interpret different scales (e.g 1:100, 1:20, 1:50)	YES / NO

21.	If yes, please specify what experience or exposure you have had with a scale ruler	In Primary School Yes / No What experience____________________________ In High School Yes / No What experience____________________________ Other: Yes / No If yes, Specify.____________________________
22.	Do you have any prior experience or exposure to read and interpretation of construction drawings?	YES / NO
23.	If yes, please specify what experience or exposure you have had to read and interpret construction drawings	In High School Yes / No What experience____________________________ Other: Yes / No If yes, Specify.____________________________

24.	On a scale of 1 – 10 please rate your **general knowledge** about the **<u>profession</u>** of Quantity Surveying	Least knowledgeable Most knowledgeable 1 2 3 4 5 6 7 8 9 10
	On a scale from 1 – 10 Please indicate your current level of knowledge in terms of the following topics:	
25.	What is your current knowledge level pertaining to reading a **scale ruler** and interpreting different scales?	Least knowledgeable Most knowledgeable 1 2 3 4 5 6 7 8 9 10
26.	To what extent do you know how to use a scale ruler to **take measurements** from a construction drawing?	Least knowledgeable Most knowledgeable 1 2 3 4 5 6 7 8 9 10
27.	What is your current knowledge level of construction drawings / building drawings for example sections, elevations, scale of drawing ect.	Least knowledgeable Most knowledgeable 1 2 3 4 5 6 7 8 9 10
28.	What is your current knowledge level of different building **materials** used in the construction of buildings?	Least knowledgeable Most knowledgeable 1 2 3 4 5 6 7 8 9 10
		Least knowledgeable Most knowledgeable

29.	What is your knowledge level of **elements and components** of a structure such as foundations, superstructure, roof, finishes etc.?	1 2 3 4 5 6 7 8 9 10
30.	What is your general knowledge level of various **professionals** in the built environment such as architects, engineers, contractors? Do you know their duties, roles and responsibilities?	Least knowledgeable Most knowledgeable 1 2 3 4 5 6 7 8 9 10
31.	To what extend are you familiar with the course of a construction project also known as a **construction timeline?**	Least knowledgeable Most knowledgeable 1 2 3 4 5 6 7 8 9 10

Thank you for your participation

Appendix 12 – Focus Group Discussion

Descriptive Quantification

FIRST YEAR STUDENTS 2022

Focus Group Interview Guidelines

Towards a Facilitation Framework for Effective Learning and Teaching for First Year Students in the Building Measurement Module.

Time: 90 min

4 – 6 students per group

Possible Questions:

1. How / why did you decide to study Quantity Surveying?
2. Let's talk about your school experience, especially grade 11 and 12. Do you feel the school environment in general (homework, teacher support, etc) as well as the subjects' content prepared you for university?
3. When you entered university what was your level of preparedness / readiness? (Follow-up question/discussion on readiness/preparedness for the building measurement module specifically).
4. If you felt underprepared for university, what would you say the reason(s) is?
5. With regards to the building measurement module, what is your experience of the content of the module? How is your class experience? Can you relate this module to other modules in the program and do you understand the core of this module and its importance to a professional quantity surveyor?
6. What does a typical class / lecture look like? What type of class activities do you do? Do you get homework, tutorial classes? What type of assignments do you do and is it group work or individual work? What type of technology do you use in class as part of learning?
7. Would you say these current teaching method(s) used in this module is effective?
8. What are the major learning / teaching **challenges** you experience in this module?
9. What do you think should change in the teaching and learning of the building measurement module?

Page 1 of 1

Appendix 13 – Interview Guidelines

Descriptive Quantification

FIRST YEAR STUDENTS' LECTURERS 2022

1st Year Lecturer Interview Guidelines

Towards a Facilitation Framework for Effective Learning and Teaching for First Year Students in the Building Measurement Module

Possible Questions:

1. How long have you been teaching this module? What is your qualification(s) and or experience? Are you a Professional Quantity Surveyor? Do you feel the lecturer need industry experience to teach this module?
2. What is your general experience of first year students in your class? In your opinion how ready/prepared are they for tertiary education?
3. How ready/prepared are the students in your class for the building measurement module and the content thereof?
4. Do you have senior first year students in your class? Is there a performance difference between senior first years and first years that just matriculated?
5. Do you think there is an articulation gap between matric and first years in general? And how does this affect this module?
6. In order for students to fully understand all elements of building measurement, building technology is important. Do you teach these two modules in conjunction with each other?
7. How do you determine baseline knowledge of your students at the beginning of the year?
8. In what ways (if any) do you adjust your teaching approach based on the readiness / preparedness level of your students?
9. What are the teaching or learning challenges that you experience in this module?
10. What is your current teaching philosophy / approach / method for this module? What activities do you do in class? What does a typical lecture looks like? Homework, tutorials, assignments?
11. How often do you revise, adapt, or change your approach to teaching and learning in this module?
12. Did it change the last couple of years?
13. Do you think your teaching methods are effective? Please explain (whether yes/no)

Page 1 of 2

14. During the COVID19 pandemic how did you navigate and manage your students in this module?
15. Do you think it is possible to effectively teach this module online?
16. What were the major challenges you experience during the pandemic in this module?
17. What does the future hold for you as lecturer in this module?

Appendix 14 – Lecturer Reflection Prompts

QUANTITY SURVEYING / CONSTRUCTION MANAGEMENT

FIRST YEAR STUDENTS 2023

Descriptive Quantification

Lecturer notes, reflections and memos

Towards Enhanced and Effective Teaching and Learning Facilitation for Building Measurement in Quantity Surveying

To be conducted by the lecturer.

Prompts:

1. What was the atmosphere in the class like today?
2. Are students interested or bored?
3. What are my general observation of today's class?
4. What are the things that I find annoying in class?
5. Do I feel that I have achieved today's goal and outcomes?
6. What can I do better or different next week?

Page **1** of **1**

Appendix 15 – Lesson Plan 1

DESCRIPTIVE QUANTIFICATION

DATE: 11 Aug 2023	Super Structure Brickwork – Unit 3	STUDENT NO:

LEARNING OUTCOME(S):
1. *After completion of today's class students will understand basic superstructure building elements of a simple single-story structure and be able to measure these basic elements.*
2. *Students will also be able to identify applicable SSMBW rules*

MATERIAL / RESOURCES:
1. *Architective/Building Construction and Graphic Standards (Andre Grobbelaar)*
2. *Measuring example #1 and presentation notes on Blackboard*
3. *SSMBW (Standard System of Measuring Building Work Document)*
4. *Stationary including scissors and glue*

SUMMARY OF TASK(S):
Students will engage in a practical example, a theoretical overview, an informal assessment, and a class activity.

Please see below questions and instructions:

Q1: In your own words please describe the following elements (Please use an illustration as well)

1.1 One brick wall (OBW)

1.2 Half brick wall (HBW)

1.3 Gable wall

1.4 Beamfilling

1.5 Two courses above ceiling level

Illustration:

Q2: Under which trade(s) does "Brickwork in Superstructure" fall? ___________________________

Q3: In what unit do we measure "Brickwork in Superstructure"? ______________________________

Q4: On a scale from 1 – 10 (where 1 is the least and 10 is the most), how would you rate your current knowledge about superstructure brickwork and measurement thereof?

Q5: Students do self-assessment on Q1.

Q6: In groups (self-select), collect images from magazines (provided in class) illustrating "Brickwork in Superstructure." Create a collage with annotations for submission.

Q7: PowerPoint presentation by lecturer on Superstructure Brickwork.

Q8: Measurement Example #1

8.1 Drawing - overview & discussion

8.2 Measurements on drawing – overview & discussion

8.3 Dimsheet discussion of measurements & calculations

8.4 SSMBW rules discussion and application

Q9: Students measure HOUSE 2 on their own (provided in class)

9.1 Discuss the drawing in groups.

9.2 Measure example 1.1 on your own on the provided dimsheet for submission.

Q10: Reflection Exercise

On a scale from 1 – 10 (where 1 is the least and 10 is the most), how would you rate your knowledge now about superstructure brickwork and measurement?

REFLECTION ON TEACHING ACTIVITIES:

To what extent did the following teaching activities help you understand today's work? In other words, the effectiveness of activities (where 1 is the least effective and 5 is the most)

- Groupwork activities (self-selected)	1	2	3	4	5
- Collage activity	1	2	3	4	5
- PowerPoint presentation	1	2	3	4	5
- Example Discussion	1	2	3	4	5

Were you able to make the connection between measurement elements and their applicable SSMBW rules?

Which activities helped you most to make this connection?

Were you able to finish the various class activities within the given time?

QUESTIONS/COMMENTS I MIGHT HAVE:	NEW TERMS LEARNED:

Appendix 16 – Lesson Plan 2

DESCRIPTIVE QUANTIFICATION
Lesson Plan
8 September 2023

LEARNING OUTCOME(S):

1. *After completion of today's class students will understand basic floor finishes and applications and the measurement thereof.*
2. *Students will also be able to identify applicable SSMBW rules of these elements.*

MATERIAL / RESOURCES:

1. *Architective/Building Construction and Graphic Standards (Andre Grobbelaar)*
2. *Measuring example #1 and presentation notes on BlackBoard*
3. *SSMBW (Standard System of Measuring Building Work Document)*

SUMMARY OF TASK(S):
Students will engage in a practical example, theoretical overview, an informal assessment and class activities.

Please see below questions and instructions:

Q1: On a scale from 1 – 10 (where 1 is the least and 10 is the most) what would you rate your current knowledge about floor finishes and application?

Q2: Please provide annotations (screed, floor application/finish, skirting etc.) on the section drawing provided also indicate the unit of measurement of each item, for submission. Please use colour in your activity.

Q3: In groups (pre-select by lecturer) discuss the various types of floor finishes and applications that you are aware of. Share with the class.

Q4: PowerPoint presentation by the lecturer on floor finishes and applications

Q5: Measurement Example #1

5.1 Drawing - overview & discussion

5.2 Measurements on drawing – overview & discussion

5.3 Dimsheet discussion of measurements & calculations

5.4 SSMBW rules discussion and application

Q6: Students measure example #1.2 on their own (provided in class)

6.1 Discuss the drawing in groups

6.2 Measure example #1.2 on your own on the provided dimsheet for submission.

Q7: Reflection Exercise

Appendix 17 – Workheet 2

DESCRIPTIVE QUANTIFICATION - Worksheet

DATE: 8 Sep 2023	Internal Finishes: Floors	STUDENT NO:

Please see the questions and instructions:

Q1: Please provide <u>annotations (screed, floor application/finish, skirting etc.)</u> on the section drawing provided also <u>indicate the unit of measurement</u> of each item, for submission. Please use colour in your activity.

Q2: In groups (pre-select by lecturer) discuss the various types of floor finishes and applications that you are aware of. Share with the class.

Q3: Students measure HOUSE2 on their own (provided in class)

3.1 Discuss the drawing in groups

3.2 Measure HOUSE2 on your own on the provided dimsheet for submission.

Appendix 18 – Reflection 2

Teaching Activity I ENJOYED the most today:

- Drawing and Annotations
- Group Discussion on Floors
- PowerPointPresentation
- Example 1 Discussion
- Measurement of House2
- Reflection Activity

Teaching Activity I LEARNED most from today:

- Drawing and Annotations
- Group Discussion on Floors
- PowerPointPresentation
- Example 1 Discussion
- Measurement of House2
- Reflection Activity

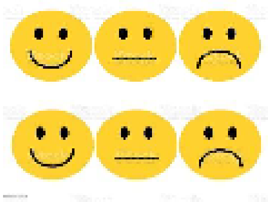
Teaching Activity I least enjoyed today and why?

New level of knowledge about floors:

/10

Did you finish your measurement work on time?

Could you manage to measure on your own?



Appendix 19 – Lesson Plan 3

DESCRIPTIVE QUANTIFICATION
Lesson Plan
27 September 2023

LEARNING OUTCOME(S):

1. *After completion of today's class, students will understand basic ceiling elements and the applications and the measurement thereof.*
2. *Students will also be able to identify applicable SSMBW rules of these elements.*

MATERIAL / RESOURCES:

1. *Architective/Building Construction and Graphic Standards (Andre Grobbelaar) notes*
2. *Measuring example #1 and presentation notes on BlackBoard & House 2*
3. *SSMBW (Standard System of Measuring Building Work Document)*

SUMMARY OF TASK(S):

Students will engage in a practical example, theoretical overview, a class activity

Q1: On a scale from 1 – 10 (where 1 is the least and 10 is the most) what would you rate your current knowledge about ceiling finishes and application?

Q2: Homework discussion (videos on ceilings)

Q4: PowerPoint presentation by the lecturer on ceiling finishes and applications

Q5: Measurement Example #1

5.1 Drawing - overview & discussion

5.2 Measurements on drawing – overview & discussion

5.3 Dimsheet discussion of measurements & calculations

5.4 SSMBW rules discussion and application

Q6: Students measure HOUSE 2 on their own (provided in class)

Q7: Reflection Exercise

Appendix 20 – Worksheet 3

DESCRIPTIVE QUANTIFICATION - Worksheet

DATE: 27 Sep 2023	Internal Finishes: Ceilings	STUDENT NO:

Please see the questions and instructions below:

Q1: Please rate your current level of knowledge on ceiling finishes

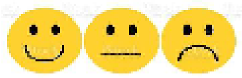
/10

Q2: Homework discussion (videos on ceilings)

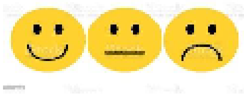
NOTES:

Q3: Measure INTERNAL FINISHES – CEILINGS of House 2 **<u>on your own</u>**

Did you finish your measurement work on time?



Could you manage to measure on your own?



New level of knowledge about ceilings

/10

Appendix 21 – Reflection 3

Please highlight the most suitable option:

To what extent did the videos <u>before class</u> help you understand the work?

- Very helpful
- Helpful to some extent
- Not that helpful
- Not helpful at all

Please highlight the most suitable description (max of 2)

Teaching Activity <u>I LEARNED</u> most from today:

- Videos at home
- PowerPoint Presentation
- Example discussion
- Own measurements

Please highlight the most suitable option:

Do you think preparation work / reading work before coming to class would help students understand the work better?

YES

NO

UNSURE

Please highlight the most suitable description **if applicable** to you (max of 2)

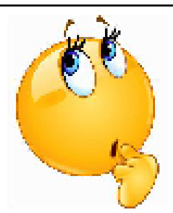
The videos were a waste of time

The videos were not that informative

I don't have access to internet

I don't have access to a computer

I would rather have the lecturer explain to me than to watch a video



Appendix 22 – Lesson Plan 4

DESCRIPTIVE QUANTIFICATION
Lesson Plan
13 October & 20 October 2023

LEARNING OUTCOME(S):

1. *After completion of today's class, students will understand basic roof elements and the applications and the measurement thereof.*
2. *Students will also be able to identify applicable SSMBW rules of these elements.*

MATERIAL / RESOURCES:

1. *Architective/Building Construction and Graphic Standards (Andre Grobbelaar) notes*
2. *Measuring example #1 and presentation notes on BlackBoard & House 2*
3. *SSMBW (Standard System of Measuring Building Work Document)*

SUMMARY OF TASK(S):

Students will engage in a practical example, theoretical overview, a class activity

<u>Week 1</u>

Q1: On a scale from 1 – 10 (where 1 is the least and 10 is the most) what would you rate your current knowledge about roofs and construction elements and measurement thereof?

Q2: PowerPoint presentation by the lecturer on roofs

Q3: Campus walkabout – roof observations and notes

Q4: Reflection

<u>Week 2</u>

Q5: Revision and test

Q6: 3D model discussion

Q7: Measurement Example #1

7.1 Drawing - overview & discussion

7.2 Measurements on drawing – overview & discussion

7.3 Dimsheet discussion of measurements & calculations

7.4 SSMBW rules discussion and application

Q8: Students measure HOUSE 2 on their own (provided in class)

Q9: Reflection Exercise

Appendix 23 – Work Sheet 4

DESCRIPTIVE QUANTIFICATION - Worksheet

DATE: 13 October 2023	ROOFS	STUDENT NO:

Please see the questions and instructions below:

Q1: In your opinion, how would you rate your current level of knowledge of roofs and roof elements as well as the measurement thereof?

/10

Q2: Powerpoint (take notes in reflection journal)

Q3: Campus walkabout (take notes on drawing provided)

Q4: Reflection:

4.1 To what extent did today's 'site visit' contribute towards your learning and understanding of roof elements and the measurement thereof? (where 1 is the least impact and 5 the most)

1	2	3	4	5

4.2 To what extent did the powerpoint contribute towards your learning and understanding of roof elements and the measurement thereof? (where 1 is the least impact and 5 the most)

1	2	3	4	5

4.3 What were your experiences of the randomly selected groups?

4.4 State two important facts that you have learned today?

4.5 Describe something you enjoyed from today's lesson

Appendix 24 – Turnitin Report

TurnItIn_MM Els PhD Final Document for Submission.docx

ORIGINALITY REPORT

9%

SIMILARITY INDEX

Appendix 25 - Language Editing

CORNELIA GELDENHUYS

✆083 2877088
corrieg@mweb.co.za

30 June 2024

TO WHOM IT MAY CONCERN

Herewith I, **Cornelia Geldenhuys (ID 521114 0083 088)** declare that I am a qualified, accredited language practitioner and that I have edited the following PhD thesis:

TOWARDS A FACILITATION FRAMEWORK FOR EFFECTIVE LEARNING AND TEACHING FOR FIRST-YEAR STUDENTS IN THE BUILDING MEASUREMENT MODULE

by

Mart-Mari Els

(Student number: 2004016669)

All changes were indicated by track changes and comments **for the author to verify, clarify aspects that are unclear, make the necessary adjustments and finalise.** The editor takes no responsibility in the instance of this not being done. The document remains the final responsibility of the author.

C. Ge

....

C GELDENHUYS
MA (Lin) cum laude, MA (Mus), BA Hons (French), HED, HDL, UELM

Accredited member/Geakkrediteerde lid, SATI, Membership/Lidmaatskap: 1001474 (A/E-E/A)
Full member/Volle lid, Professional Editors Guild (PEG, Membership GEL001)
Mediterranean Editors and Translators (MET: Membership 02393)
European Association of Scientific Editors (EASE: Membership 5523)

Appendix 26 – Methodology Alignment

Research Question	Research Objective	Data Collection Tool(s)
How can the learning and teaching of first-year students in the building measurement module be enhanced through a facilitation framework	This research aims to develop a guiding framework to facilitate and enhance learning and teaching of the building measurement module on first-year level to mitigate and address potential teaching and learning challenges associated with quantity surveying students at University	Combination of Methodology 1 and Methodology 2
What is the extent of the preparedness level of first-year quantity surveying students in terms of prior knowledge or lack thereof to deal with the building measurement module content?	To determine the preparedness level of first-year quantity surveying students in terms of prior knowledge or lack thereof to better deal with the Building Measurement Module.	Methodology 1: Baseline survey, focus group discussions, semi-structured interviews
What is the nature of the challenges associated with the learning and teaching of first-year quantity surveying students in the building measurement module in South Africa?	Identify the nature of the challenges associated with the teaching and learning of first-year quantity surveying students in the Building Measurement Module in South Africa.	Methodology 1: Baseline survey, focus group discussions, semi-structured interviews
What are the current approaches and techniques used in the learning and teaching of building measurement for first-year quantity surveying students in South Africa?	To examine current learning and teaching approaches and techniques used in the learning and teaching of building measurement for first-year quantity surveying students in South Africa.	Methodology 1: Focus group discussions, semi-structured interviews
What is the perceived effectiveness of the current learning and teaching approaches and of building measurement for first-year quantity surveying students in South Africa?	To identify learning and teaching interventions that can be applied to bridge the knowledge gap of first-year students regarding the building measurement module.	Methodology 1: Focus group discussions, semi-structured interviews
What facilitation framework towards effective learning and teaching interventions can be applied to bridge the articulation gap of first-year students to in order for them to fully grasp and understand the context of the building measurement module?	To develop a guiding framework to enhance the facilitation of learning and teaching of building measurement to first-year quantity surveying students and support them better to develop the required basic and professional skills.	Methodology 2: Case study approach