An exploration of quantity surveying students' engagement with engineering graphics and specification drawings

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Declaration

I hereby declare that "**An exploration of Quantity Surveying Students' engagement with engineering graphics and specification drawings"** is my own work and that all the sources I have used or quoted, have been indicated and acknowledged by means of complete references.

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December 2016

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Dedication

This thesis is dedicated to my wife, **Leticia** and daughters, **Victoria, Bridget, Emmanuelle and Christabelle**. Thank you for your unconditional love, patience, support and motivation. You have encouraged me to aspire to greater heights and have prevented me from throwing in the towel when I felt overwhelmed on this journey. I love you dearly.

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Finally my Lord and Saviour who gave me strength, hope and faith that through perseverance nothing is impossible with God.

Luke 1 verse 37.

Abstract

This study sought to explore N4 Quantity surveying students' engagement with engineering Graphics and specification drawings at the Durban Computer College in a class taught by the researcher.

The study was guided by the following research questions:

1. How do N4 QS students' engage with the assessing and processing of information from engineering graphics and specification drawings?

2. Why N4 QS students engage with the assessing and processing of information from engineering graphics and specification drawings the way they do?

3. What factors promote or impede N4 QS students' engagement with the assessing and processing of information from engineering graphics and specification drawings?

To address these questions a qualitative case study design approach is used. Data was generated through a task based activity, individual interviews, collages, concept maps and reflections. The conceptual framework guiding this study embraces experiential learning theory (Kolb, 1984) as well as the model adapted by Strydom andMentz (2010a)forthe South African Survey of Student Engagementoriginally designed by Kuh (2007, p. 11). Purposive and convenience sampling was used to identify the respondents for this study. Data collected was subjected to content analysis.

The findings from the task based activity indicate that N4 QS students encounter difficulty in reading and interpreting engineering graphics and specification drawings. These students remain stuck at the concrete experience phase of Kolb's experiential learning theory(ELT) and do not move along the continuum to the level of abstract conceptualisation. This means that facts or content pertaining to QS are learnt as unrelated issues in an isolated manner, hence the participants were unable to transfer/apply information to another situation, perform simple calculations or abstract information to prepare the bill of quantities. Individual interview conducted with N4 QS students revealed the following eight aspects emerged as their rationale for assessing and processing information from engineering and graphics and specification drawings the way they do, namely: student background, perception of learning environment, teaching style, study habits, carelessness, lack of literacy skills to read diagrams, lack of numeracy skills to perform simple calculation and lack of awareness of the standard system. Data from the collage and concept maps

illuminated the factors that impeded or promoted N4 QS students' engagement with the assessing and processing information from engineering and graphics and specification drawings. The factors that impede engagement were: carelessness, lack of literacy skills to read diagrams, lack of numeracy skills to perform simple calculations, lack of awareness of the standard system, students' inability to juggle family responsibilities with study responsibilities, anxieties, confusion, being overwhelmed by large volumes of content information and jargon. The factors that can promoted N4 QS students' engagement with the assessing and processing information from engineering and graphics and specification drawings were: equipping students with the skills needed to cope with the module content, breaking the content into smaller bits that are more comprehensible, changing my teaching methods, having more hands-on activities, having a positive expectation of students as well as getting to know them. Reflecting on my teaching and the three phases of data generation has made me realise the intricately intertwined connectedness between context, student engagement and my teaching.

The findings of this study result in a proposed intervention at XYC for student teacher interaction, modelling of engaging teachers and managing of disengaged students.

Key words: assessing and processing information; bill of quantities; engineering graphics and specification drawing, quantity surveying student engagement.

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List of Acronyms

AC: Abstract Conceptualisation

AE: Active Experimentation

BQ: Bill of quantities

CE: Concrete Experience

ELT: Experiential learning theory

EGD: Engineering Graphics Design

RO: Reflective Observation

MPa: Mega pascal

N4: National level 4

QS: Quantity Surveying

CHAPTER 1 : INTRODUCTION

1.1 Introduction and background

South Africa's development is being hampered by a serious shortage of skilled engineers, quantity surveyors (QS), construction managers and construction project managers (Republic of South Africa, 2012). Consequently, as a result of the aforementioned shortages South African encountered serious problems with housing service delivery due to factors such as fraud, absentee contractors, shoddy workmanship, and corruption. Some R300-million was spent on rectifying houses in the North-West Province, and about R500-million was spent rectifying improperly built homes in KwaZulu-Natal (Sexwale, 2009). These are the issues that quantity surveyors address through preventing managing and resolving through arbitration.

The job of the quantity surveyor is a crucial one as it is his or her task to manage the value-for-money and cost of building projects (Azodo, 1993). These responsibilities involve tracking costs from initial calculations to the final figures, and a quantity surveyor must balance the task of minimising costs with maintaining high quality standards. Quantity surveyors act in liaison with architects, consulting engineers and contractors to safeguard the client's interests. Furthermore, they are expected to prepare a Bill of Quantities (BQ). To be able to prepare the BQ the QS must be *au fait* with the technique of measuring quantities from drawings, sketches and specifications prepared by designers, principal architects and engineers, in order to prepare tender/contract documents, which is known in the industry as 'taking off'. In other words, they must be able to read, assess, interpret and process information from engineering graphics and specification drawings. Engineering graphics and specification drawings are an important means of communication between engineers, technicians and professionals involved in design and production (Sotsaka, 2015). As such, engineering graphics and specification drawings are used to describe products, and give instructions about their manufacture, assembly and operation. These drawings are clear, complete and accurate, so as to prevent expensive and/or dangerous mistakes for manufacturers or customers. To be able to prepare a BQ, QSs are expected to take measurements from scaled orthographic drawing and specifications and quantify work and

materials, describing the quality of workmanship, quantity and quality of materials to be used. If a QS is incapable of reading the engineering graphics and specification drawings accurately then firms/contractors will lose contracts/money/profit/productivity and their reputation. Therefore, there are preceding core skills which must be inherent in all graduates from QS courses. Many students find this subject difficult to grasp, especially the reading and interpreting of engineering graphics and specification drawings. Thus, there is a substantial gap between the supply and demand of affordable, capable, competent and qualified QSs in South Africa.

1.2 Rationale

I have been lecturing QS for the past 21 years. The QS curriculum places much emphasis on training students in engineering specification drawing and foregrounds the analysis of the constructional details of orthographic drawing and the relationship to its isometric counterpart so that the QS students can effectively measure and quantify work and materials required by contractors. In spite of the preceding curricular requirements I have observed that when QS students are tasked to measure, quantify work and materials from engineering graphics and specification drawings, most students lack the skills to effectively interpret drawing and retrieve the required information. Furthermore, I have observed that the enrolment rate in QS is low and the dropout rate is high. This means that only a handful of students manage to complete the qualification, graduate and enter the world of work. Additionally, those students that do manage to complete their studies experience difficulty in finding employment. Bearing the above points in mind, I believe that merely getting a list of QS students' misconceptions pertaining to engineering graphics and specification drawings is insufficient and that delving more into students' engagement/challenges may be beneficial to me and the students. It is for the these reasons that I became interested in exploring how N4 QS students' engage withassessing and processing information from engineering graphics and specification drawings. Zepke (2013) maintains that when lecturers underscore student engagement during their teaching, the engagement is a partnership between students, their lecturers and institutions where each member contributes towards quality education. In a similar manner Bowie (1998, p. 5) argues that "research studies on students misconceptions have provided insights into difficulties students have in dealing with concepts, but analysing these misconceptions could provide information about the difficulties they face in learning these concepts". I believe that gaining a deeper insight into the kind of rationale,

reasoning and quality of effort N4 QS students put into their engagement of engineering graphics and specification drawings is beneficial at two levels. First it will allow me to gain a more nuanced practice by reflecting on the difficulties encountered by students of differing abilities and experience. Second it will enable more fruitful learning experiences for QS students in terms of engineering graphics and specification drawings.

My study aims to, not only provide a detailed description of students 'difficulties', but probe the probable underlying reasons for their particular misconceptions and determine how previously acquired concepts impact on their understanding of assessing and processing information from engineering graphics and specification drawings.

1.3 Purpose of this study

The objectives of this study were:

1. To explore how N4 QS students engage with assessing and processing information from engineering graphics and specification drawings.
2. To ascertain why N4 QS students engage with assessing and processing information from engineering graphics and specification drawings the way they do.
3. To identify the factors that promote and impede N4 QS students' engagement with the assessing processing information from engineering graphics and specification drawings.

1.4 Research question

The research questions guiding this study are:

1. How do N4 QS students' engage with the assessing and processing of information from engineering graphics and specification drawings?

2. Why N4 QS students engage with the assessing and processing of information from engineering graphics and specification drawings the way they do?

3. What factors promote or impede N4 QS students' engagement with the assessing and processing of information from engineering graphics and specification drawings?

1.5 Significance of this study

This study will be beneficial to me and other QS lecturers as it would provide deeper insights on how QS students engage with assessing and processing information from engineering graphics and specification drawing and why they process information the way they do so that we can develop appropriate pedagogical strategies to lecture this section.

Quantity Surveying Curriculum developers will also benefit from this study as it will provide insights on the sequencing of topics, sections in the QS curriculum.

1.6 Limitations of this study

A case study method was used in this study which explored N4 QS students' engagement with engineering graphics and specification drawings. The study was located at the Durban Computer Collage (DCC). It is possible for the case study methods to be criticised because the results cannot be generalised. However, it is worth noting that Flyvbjerg (2006) emphasises the value of single cases of experiments by Galileo, Newton, Einstein, Bohr, Darwin, Marx and Freud to confirm that both human and natural sciences could be advanced by a single case. In addition, Erickson (1986) argues that because the general lies in the particular, what we learn in a particular case can be transferred to similar situations. Consequently, despite its limitations, a case study can further our insight into similar situations. Further, the perceived limitation is overcome by the provision of rich thick descriptions of the case at hand (Shuttleworth, 2008).

1.7 Clarification of terms

Bill of quantities: The bill of quantities (BQ) is a document prepared by the quantity surveyor that itemises the quantities of materials on a construction project. It entails extracting information from the engineering graphics and specification drawing.

N4: This is a post matric national certificate programme towards obtaining a National N-Diploma in Quantity Surveying. Each certificate (N4-N6) is a qualification on its own and is offered over a period of 3 months.

1.8 Overview of chapters

This dissertation is organised into five chapters. The present chapterhasset the stage and motivation for the study. It acquainted the reader with the objectives and research questions, significance and limitations of the study.

Chapter 2 will focus on a review of relevant literature and elucidates the conceptual framework used in the study. The literature reviewed was guided by the research questions. Kolb's experiential learning theory (ELT) and the model adapted by South African Survey of Student Engagement (Strydom & Mentz, 2010a) originally designed by Kuh (2007, p11) form the conceptual framework of the study.

Chapter 3sets the stage for the research methodology used to answer the research questions. The chapter provides reasons for the choice of research method and case study design, and methods of data analysis. The development of materials, and processes undertaken to improve the different data collection tools and hence the reliability of results are discussed in depth. Ethical aspects of the research are coincided.

Chapter 4 covers data analysis. Field data collected according to the research methodology is analyzed against the theoretical framework, in order to answer the research questions posed in this study. The final chapter consists of a critical discussion on key findings of the research.

Chapter 5 elucidates the literature reviewed and the conceptual framework adopted for the study.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

The classroom experience is central to student success. For most students, the classroom is often the only place where they meet each other and engage with their peers and teachers in learning activities. This research study is concerned with finding effective, practical ways to engage N4 QS students, at a particular level of higher education in order to provide enriching student engagement experiences that will result in improved academic performance. Quantity surveyors are construction economists who fulfill varied and comprehensive duties to support cost-effective construction and property development projects. The core competencies of QSs include determining project budgets, measuring project quantities, preparing contract documentation (such as BQs and cost control documents), administering contracts, and preparing final accounts.

This research study sought to explore N4 QS students' engagement with engineering graphics and specification drawings during the drawing up of the BQ. Student engagement is an amalgam of how topics are arranged in the curriculum, teaching style, the compatibility of students' learning style to the teachers teaching style and contextual factors. First, this chapter sets out to provide an insight into the literature reviewed. The literature reviewed was aligned with the topic and research questions and focused on student engagement, sequencing of topics in the curriculum, teaching of Engineering Graphics Design (EGD), learning styles and teaching styles while the interpretative paradigm requires the literature review to embrace reflective teaching practice. I have consulted literature pertaining to the teaching of EGD as there is a paucity of literature on the teaching of engineering graphics and specification drawings pertaining to QS. This is the gap that this study aims to address. Second an elaboration is provided on the conceptual framework. The conceptual framework comprises of experiential learning theory and the model adapted by South African Survey of Student Engagement (Strydom & Mentz, 2010a).

2.2 Literature review

The literature reviewed focuses on student engagement, sequencing of topics in the curriculum, teaching of EGD, learning styles, teaching styles and transformational teaching.

2.2.1 Student engagement

Over the last decades, the concept of student engagement has attracted scholars' attention. Today, "there is no doubt that engagement is currently a very hot topic in the broad field of school achievement" (Wang & Eccles, 2012, p. 137). Student engagement has been defined as "students' psychological investment in and effort directed towards learning, understanding or mastering the knowledge, skills or crafts that academic work is intended to promote" (Newman, 1992, p. 12). This definition can be viewed as focusing only on the psychological dimension of the learner in the learning process. The term was defined later as "a psychological process, specifically, the attention, interest, investment, and effort students expend in the work of learning" (Marks, 2000, p. 154). This definition seems to lack a concrete element that could easily identify an engaged from a disengaged student. In this regard, Marks specifies that "engagement implies both affective and behavioural participation in the learning process" (Marks, 2000, p. 155), thus addressing a concern about observable behaviour in activities of learning. Thereafter, Willms (2003, p. 8) notes that the term refers to "students' attitudes towards schooling and their participation in school activities" and Chapman (2003) (as cited in Zepke and Leach, 2010) defines the concept as the students' cognitive investment in, active participation in and emotional commitment to their learning. More recently, student engagement has been defined as the "students' involvement with activities and conditions that are likely to generate high-quality learning" (Radloff, 2011, p.5). Therefore, this concept is substantially "defined by two key components: first, what students do (the time and energy they devote to educationally purposive activities) and second, what institutions do (the extent to which they employ effective educational practices to induce students to do the right things)" (Strydom & Mentz, 2010b, p.3).

Student engagement refers to students' involvement, participation, effort and time devoted to learning activities within the teaching and learning environment, at the classroom level. In this regard, a student's effort reflects the way he or she goes about learning a particular course. Consequently, engagement tends to lead to success while disengagement tends to lead to failure.

In this study, student engagement is taken as an important factor that influences performance. Student engagement focuses on the extent to which students are engaging in activities which have been shown to be linked with high quality learning outcomes. Hu and Kuh (2002, p. 3) define engagement as "the quality of effort students themselves devote to educationally purposeful activities that contribute directly to desired outcomes". Drawing from the work of Quaye and Harper (2009) and Kahu (2013), student engagement can be defined as playing an active role in effective educational practices shaped by individual psychological processes and socio-cultural contexts. This definition views student engagement from four interlinked perspectives. These are the behavioural, psychological, socio-cultural and holistic perspectives (Kahu, 2013). Each of the four perspectives discussed offers useful and relevant insights into this complex construct. The behavioral approach highlights the importance of student behavior and institutional practice; the psychological approach clearly defines the state of being engaged and acknowledges the essential role of affect; the socio-cultural perspective foregrounds the social-cultural context in which student engagement takes place and finally; the holistic approaches recognises the need to consider the students own motivations and expectations (Kahu, 2013). A key strength of envisaging engagement in this way is the acknowledgement of the individuality and uniqueness of every student.

Zepke (2013) understands student engagement as a partnership between students, their lecturers and institutions where each member contributes towards quality education. Both views of student engagement are adopted in this study. While institutions, parent and peers support learning, the final responsibility for learning rests with students. The nature, depth and degree of learning are also dependent on how the students maximise the use of their resources that becomes accessible to them. Research on student engagement is supported by the constructivist view that education is about students constructing their own knowledge (Matthews, 1998).

2.2.2 Scope, sequencing, continuity and integration of topics in the curriculum

Whilst the organisation of the official N4 QS curriculum is arranged at a national level, how a lecturer chooses to follow this curriculum in the lecture room may differ depending on the learning styles of his/her students. The organisation of a curriculum in terms of its scope, sequencing,

continuity and integration of topics impacts both teaching and learning. Therefore, it is important to unpack what these processes entail.

Scope refers to the breadth and the depth of content in a curriculum (Ornstein & Hunkins, 2009). This content must include both the knowledge domain and aspects, such as affective (values and attitudes) and, where appropriate, psychomotor skills. This is often the discipline-specific and generic skills required in a curriculum. The challenge in deciding on the scope of a programme has been the huge information explosion in the last 20-30 years. According to Ornstein and Hunkins (2009) teachers have adopted the following strategies to cope with the information explosion: reducing content; ignoring certain content; excluding, or alternatively focusing on, new content; integrating existing content into themes and increasing the emphasis on life-long learning and information retrieval skills.

There is a danger in trying to achieve a very wide scope in a curriculum that "as students race through the topics, they have less opportunity to engage in the process of sorting, comparing, prioritizing and critiquing… ideas: (Clark & Linn, 2003, p. 17). Therefore, a balance needs to be found on how much to cover because information overload can lead to a more surface approach to learning, where students then fail to remember the information at a later date Knight (2001). This means that it is important that the curriculum should not be overcrowded, there should be opportunity for depth study*;* and time for strategic thinking, reflection, planning.

The sequence of topics in a curriculum focuses on the order in which things occur. This means that sequencing relates to when different parts of the curriculum should be learned with respect to the other parts of the curriculum (Ornstein & Hunkins, 2009). There is a long-standing controversy over whether the sequence of content and experiences should be based on the logic of the subject or the way individual's process knowledge (Ornstein & Hunkins, 2009, p187). According to Toohey (1999) content can be sequenced by time (history course), spatial relationships (country in geography); species: simple to complex (biology); forms of expression (art: drawing, painting, sculpture) (literature: poetry, prose, drama); functional systems (respiratory, digestive: medicine); processes (human resource management: life cycle of employee for recruitment to retirement) or a combination of some of these. With regard to the preceding dilemma, Ornstein and Hunkins (2009), assert that there are four different ways of approaching the sequence design of a curriculum:

- Simple to complex learning;
- Prerequisite learning (bits grasped before others);
- Whole to part (inquiry / PBL / concept); and
- Chronological learning. (Ornstein & Hunkins, 2009, p. 9)

Simple to complex learning implies that content is optimally organised in a sequence proceeding from simple subordinate components to complex components. Teachers make use of this idea by teaching from known relevant previous knowledge of the learner to new topics and ideas that are totally unfamiliar to

him/her. This allows the teacher to highlight the interrelationship between what the learner already knows and what he has been introduced, moving from easy (often concrete) content to more difficult (often abstract) content.

Prerequisite learning works on the assumption that bits of information must be grasped before other bits can be comprehended, for example in teaching roof truss, the individual members of the roof truss (rafters, struts, king posts, queen posts and the tie beam) and how they are arranged as a unit to carry roof loads must be explained before the truss as a unit and its function is comprehended.

Whole to part learning receives support from cognitive psychologists. They have urged that the curriculum be arranged so that the content or experience is first presented in an overview that provides students with a general idea of the information or situation. For example QS lecturers should present to the learner the duties and function of the QS (taking measurement from drawings, preparing a BQ, preparing tender documents, managing cost control on behalf of the employer), before attempting to explain in detail how to draw up checklists for the substructure foundation, the superstructure floors, walls, doors and windows and roofing; and measuring from the checklists of the entire structure.

Chronological learning refers to content whose sequence reflects the times of real world occurrences. Many construction activities on site follow an order of mandatory dependencies (e.g. site clearance, excavation of surface trench, casting of concrete in footings, erecting of masonry in footing, backfilling trenches, and hard core fill to underside of ground floors) to show the

chronological order of constructing the foundation of a building. In general foundations are built first before ground and upper floors, columns, beams, walls, and roofs can literally be constructed. It will therefore be important to teach substructure foundation construction before teaching super structure and roof construction, for example.

Whereas scope is associated with horizontal curriculum design, continuity is often described as the vertical integration of the curriculum design (Ornstein & Hunkins, 2009). Continuity in a curriculum provides a student opportunities to revisit knowledge and skills in more depth as they progress through the years. "Students succeed best ... when such skills (higher order) are reinforced throughout their educational programme. Students learn best … when they are required to synthesise knowledge and skills learned in different places … ." (Astin, Banta, Cross, El-Khawas, Ewell, Hutchings … & Moran, 1992, pp. 5-8).

Continuity can be in the subject matter, but can also be in other skills such as team-working and problem-solving. Assessment procedures should reflect this developmental approach, by requiring students to achieve higher-order cognitive competencies, for example, to judge and debate issues. Alternatively, assessments can require students to build higher levels of responsibility or autonomy in a skill, i.e. peer/self-assessment.

Integration is concerned with the linkages of information so that students can develop a holistic overview of the curriculum. Integration of knowledge has been described by some as more than just making links within a curriculum, but as linking curriculum to real-world themes (Ornstein and Hunkins, 2009). Modularisation has been criticised for its lack of attention to integration. Integrative learning "comes in many varieties: connecting skills and knowledge from multiple sources and experiences; applying theory to practice in various settings; utilising diverse and even contradictory points of view; and, understanding issues and positions contextually(Huber & Hutchings, 2004, p. 13).Knowledge integration is linked with the idea of continuity as Clark and Linn (2003) maintain that knowledge integration takes time, energy, varied activities and many opportunities to make connections. "Student learn best… when they are required to synthesise knowledge and skills learned in different places…."(Astin, et al, 1992, pp. 5-8).

2.2.3 Learning styles

While we use all of our senses to take in information, we each seem to have preferences in how we learn best. One of the most important uses of learning styles is that it makes it easy for teachers to incorporate them into their teaching and assessment activities. In order to help all students learn, we need to teach to as many of these preferences as possible (Cuaresma, 2008). Mismatches between an instructor's style of teaching and a student's method of learning have been cited as potential learning obstacles within the classroom and as a reason for using a variety of teaching modalities to deliver instruction. Brown (2000) defines learning styles as the manner in which individuals perceive and process information in learning situations. Celce-Murcia (2001) defines learning styles as the general approaches—for example, global or analytic, auditory or visual—that students use in learning any other subject. So learning styles refer to the manner in which a learner perceives, interacts with, and responds to the learning environment.

According to Gilakjani and Ahmadi (2012) there are three main learning styles; visual, auditory, and kinaesthetic. **Visual learners** think in pictures and learn best in visual images. They depend on the instructor's or facilitator's non-verbal cues such as body language to help with understanding. Visual learners favour sitting in the front of the classroom. They also take descriptive notes regarding the material being presented (Gilakjani & Ahmadi, 2012). **Auditory learners** discover information through listening and interpreting information by the means of pitch, emphasis and speed. These individuals gain knowledge from reading out loud in the classroom and may not have a full understanding of information that is written (Tulbure, 2011). Auditory learning is achieved from discussions during collaborative learning events such as peer learning, debates, games and answering questions (DiCarlo & Collins, 2001). **Kinesthetic learners**, learn best with an active "hands-on" approach. Such learners prefer manipulative models (Chan, Pisegna, Rosian & DiCarlo., 1991) and role playing (Kuipers & Clemens, 1998), simulation models, debates and games which promote active learning in large classrooms. Many engineering students learn better in this way (Tierney & Brunton, 2005), when after designing their artifacts they go to the workshops and use machines like lathes and hand tools to realise the artifacts.

Students with knowledge of their own preferences are empowered to use various techniques to enhance learning, which in turn may impact overall educational satisfaction. This ability is particularly critical and useful when an instructor's teaching style does not match a student's learning style. Dunn and Dunn (1978) write that "learners are affected by their: (1) immediate environment (sound, light, temperature, and design); (2) own emotionality (motivation, persistence, responsibility, and need for structure or flexibility); (3) sociological needs (self, pair, peers, team, adult, or varied); and (4) physical needs (perceptual strengths, intake, time, and mobility)" (p, 21). According to Dunn and Dunn (1978) the above mentioned factors shape the learners learning style. They claim that not only can students identify their preferred learning styles, but that students also score higher on tests, have better attitudes, and are more efficient if they are taught in ways to which they can more easily relate. Therefore, it is to the educator's advantage to teach and test students in their preferred styles (Dunn & Dunn, 1978).

Students may be inclined to approach their courses or subjects in one of three ways. Those with a reproducing orientation tend to take a surface approach to learning, relying on rote memorisation and mechanical formula substitution and making little or no effort to understand the material being taught. Furthermore, they take a narrow view and concentrate on detail, fail to distinguish principles from examples and are afraid of failure.

Those with a meaning orientation tend to adopt a deep approach, probing and questioning and exploring the limits of applicability of new material. Students who take a deep approach have the intention of understanding, engaging with, operating in and valuing the subject. Such students:

- Actively seek to understand the material / the subject;
- Interact vigorously with the content;
- Make use of evidence, inquiry and evaluation;
- Take a broad view and relate ideas to one another;
- Are motivated by interest;
- Relate new ideas to previous knowledge;
- Relate concepts to everyday experience; and
- Tend to read and; study beyond the course requirements.

Those with an achieving orientation tend to use a strategic approach, doing whatever is necessary to get the highest grade they can, taking a surface approach if that suffices and a deep approach when necessary. Students taking this approach:

- Intend to obtain high grades;
- Organise their time and distribute their effort to greatest effect;
- Ensure that the conditions and materials for studying are appropriate;
- Use previous exam papers to predict questions; and
- Are alert to cues about marking schemes.

A goal of instruction should be to induce students to adopt a deep approach to subjects that are important for their professional or personal development. Students' approaches to learning can vary according to students' perceptions of their learning environment. A student who takes a deep approach to one subject, or even part of a subject, may take a surface approach in relation to something else. Educators can influence students' approaches by the way they design subjects and courses, particularly the assessment. Inquiring into the approaches that students are taking and the reasons they give for taking these approaches can be very enlightening, and an excellent way of informing changes to teaching and subjects. Scholars such as Felder and Silverman (1988) indicate that mismatches between learning styles of engineering students and teaching styles of engineering professors are the reason why engineering students become bored, inattentive in class, do poorly in tests, get discouraged and sometimes change curricula or drop out of college. The situation is resolved as lecturers and teachers match teaching styles to students' learning styles.

How students approach a learning task will strongly influence the quality of their learning outcomes. Students' approaches to learning are not fixed characteristics they can change. Researchers such as Craik and Lockhart (1972) and Craik and Tulving (1975) have shown that information processed to a 'deep' level will be better remembered than information processed only to a 'shallow' level. Studies have shown deeper approaches to learning are related to higher quality learning outcomes (Ramsden, 1992; Prosser & Millar, 1989; Trigwell & Prosser, 1991).

The knowledge of students' preferred learning style is vital if educators are to provide tailored strategies for individual students (Armstrong & Parsa-Parsi, 2005). It also helps to overcome the predisposition of many educators to treat all students in a similar way as well as to motivate teachers to move from their preferred mode(s) to using other modes. In so doing they can reach

more students because of the better match between teacher and learner styles (Bergman & Fors, 2005). It may be difficult to tailor course work to the individual learning style, however by being aware of their learning styles, students may contribute to their academic success by promoting learning strategies that work for them (Tanner & Allen).

In a similar vein, Biggs (1999) suggested that good teaching can influence students to take a deep approach, while poor teaching in the widest sense can pressure students to take a surface approach. Biggs defines good teaching as the encouragement of a deep approach to learning.

2.2.4 Teaching style

A teaching style classifies the instructional method according to how well it addresses the proposed learning styles of students. Studies by Felder and Silverman (1988) and Waldheim (1987) indicate that most learning and teaching styles parallel one another. Some teachers lecture, others demonstrate or discuss, some focus on principles, others on application, some emphasise memory or understanding. Studies by McGlynn (2008) and Peck, Ali, Matchock and Levine (2006) found that teaching techniques that encourage students to actively engage in/with material promote deeper levels of thinking and better facilitate encoding, storage and retrieval than traditional lectures.

Although the styles by means of which students learn are numerous, the inclusion of a relatively small number of techniques in an instructor's repertoire should be sufficient to meet the needs of most or all the students in any class. Felder and Silverman (1988), therefore, recommendthe following teaching techniques to address all learning styles.

- Motivate learning as much as possible using materials close and similar to what has come before and not foreign to the students' personal experience (*inductive/global*).
- Provide a balance of concrete and abstract concepts (*sensing and intuitive*).
- Balance materials that emphasise practical problem-solving methods (*sensing/active)* with materials that emphasise fundamental understanding (*intuitive/reflective*).
- Provide explicit illustration of intuitive patterns (logical inference, pattern recognition, generalisation) and sensing patterns (observation of surroundings, empirical experimentation, attention to details), and encourage all students to exercise both patterns (*sensing/intuitive*).

- Use pictures, schematics, graphs, and simple sketches liberally before, during, and after the presentation of verbal material (*sensing/visual*), hands-on (*active*), show films (*sensing/visual*),provide demonstrations (*sensing/visual*).
- Follow the scientific method of presenting theoretical material by providing concrete examples of the phenomena the theory describes or predicts (*sensing/inductive*), develop the theory (*intuitive/inductive, sequential*); then show how the theory can be validated and deduce its consequence (*deductive/sequential)* and show possible application (*sensing/deductive/sequential*).
- Use computer assisted instructions –sensors respond very well to these (*sensors/active*).
- Do not fill every minute of the class time lecturing and writing on the board. Provide intervals – however brief – for students to think about what they have been told (*reflective*).
- Provide opportunities for students to do something active besides transcribing notes. Small group brainstorming activities that takes not less than five minutes are extremely effective for this purpose (*active*).
- Assign some drill exercises to provide practice in the basic methods being taught (*sensing/active/sequential*) but do not over do them (*intuitive/reflective/global*). Also, provide some open-ended problems and exercises that call for analysis and synthesis (*intuitive/reflective/global*).
- Give students the option of cooperating on homework assignments to the greatest possible extent (*active*).Active learners learn best when they interact with others. If they are denied the opportunity to do so they are being deprived of their most effective learning tool.
- Applaud creative solutions (*intuitive/global*).
- Talk to students about learning styles, both in advising and in classes, assuring them their academic difficulties may not be due to personal inadequacies. Explaining to struggling sensors or active global learners how they learn most effectively may be an important step in helping them reshape their learning experiences so that they can be successful (*all types*).

2.2.5 Transformational teaching

The theory of transformational teaching can be defined as the process of creating dynamic relationships between teachers, students and a shared body of knowledge in a way that promotes

student learning and personal growth. Teachers are viewed as intellectual coaches who create teams of students who collaborate with each other and their teachers to be masters of information. Teachers assume their duties of facilitating key concepts to students, at the same time promoting students' personal development and enhancing their disposition toward learning (Slavich & Zimbardo, 2012).

Rosebrough and Leverett (2011, p. 53) define transformational teaching as "an act of teaching designed to change the learner academically, socially and spiritually". They argue that education should be more about inspiration than information. Instructors or teachers are encouraged to consider the importance of equipping the students with skills and attitudes necessary for overcoming challenges. Fundamental to this formulation of transformational teaching is that instructors can guide learners toward making self-discoveries that shape their fundamental beliefs about themselves. In contrast with traditional lecturing, which largely involves unidirectional transfer of information from instructor to students, transformational teaching involves conceptualizing the teacher as a change agent who leads students in the process of collaborating with each other and with their instructor to develop as learners and people (Rosebrough & Leverett, 2011).

To achieve transformational teaching, students need to be allowed to engage in a process of interdependent discovery by giving them time to discuss strategies they use and knowledge they produce. This approach examines the role teacher's play in transforming student's attitudes, beliefs and values as well as the responsibility that learners have of shaping their peers and their own learning experience.

2.2.6 Teaching of EGD

Like any language, engineering drawing as a means of communication consists of technical rules or drawing conventions (Olkun, 2003). In engineering, lines and symbols are a more effective means of communicating thoughts than verbal descriptions. Therefore all people related to the technical industry should be capable of reading or interpreting a drawing accurately. Thus there is a non-negotiable need to learn how to read and write a drawing. As with language, one needs to know and use the conventions and rules in order to apply the rules; certain skills are needed, especially spatial perception and visualisation as well as spatial ability. Olkun (2003) maintained

that spatial thinking is essential for scientific thought as it is used to represent and manipulate information in learning and problem solving (Clements & Battista, 1992). In support of this, Kovac (1989) has pointed out that spatial ability is the mental manipulation of objects and their parts intwo-dimensional (2D) and three-dimensional (3D) space and can be improved through appropriate activities. Resonating with the aforementioned sentiments, Kabouridis (2010) maintains that for EGD learners, visualisation skills are very important for understanding fundamental concepts of drawing. Therefore, the curriculum should include and emphasise such skills and these skills should be foregrounded in teaching.

Many learners have difficulty in understanding or comprehending the graphic representation of 3D objects. According to Perez Carrion and Serrano (2012), the high failure rate of school learners in their exit examinations in EGD is due to the difficulty of understanding the mechanisms related to the representation of 3D objects in 2D. This means that learners have not sufficiently developed their spatial ability. Branoff, Hartman and Wiebe (2013) contend that EDG teachers must expose learners to hands-on experience of drafting techniques, drafting standards and conventions. In order to do this, the curriculum should expose learners to practical engineering graphic skills and knowledge about how various design components and systems relate and work together on any given project. These competencies develop only by engaging learners in activities that target the problem-solving skills and the ability to think, see, create and model 3D visual images in space or on paper from 2D blueprints using a variety of media. The implication for teaching is that these skills cannot be developed "by rote learning or memorisation". In addition, learners should be exposed to emerging trends in technical graphics, developments in industrial technologies and advances in computer technology. Simply put, this means that EGD learners have to be trained in developing spatially-related problem-solving abilities (Kabouridis, 2010). One major limitation of traditional instruction is the problem of presenting 3D in 2D format. The challenge is overcome if learners are presented with real objects and are instructed to draw a chosen front view and a top view/plan using a convenient scale to represent the 3D object in 2D autographic format. If this is done using a computer the learner can see the drawing unfolding before his/her eyes and immediately understands the drawing procedure.

To reconstruct the 3D object from the 2D drawings all that is required of the learner is to superimpose the top view/plan on top of the front view or sectional elevation; and the 3D is

generated from the 2D autographic views. The advantage of using a computer in these processes is that the learners sees the inter-conversion of 3D to 2D and vice-versa unfolding before their own eyes. Learners in collaborative learning can repeat the computer simulation several times to consolidate their understanding. Once this has been achieved, the process of measuring and quantifying work and materials by the student QS will be easy to follow.

2.2.7 Linking engineering specification drawings to the Bill of Quantities (BQ)

According to the Australian Institute of Quantity Surveyors. (n.d.)the BQ is a document which itemises the quantities of materials on a construction project. The preparation of the Bill of quantities is the principle activity of a quantity surveyor (Hore, 2010). The BQ has been prepared in various forms for the last 300 years and is an integral part of documentation in construction (Milliken, 1996). The BQ translates the requirements depicted in the drawings and describes the specification in the form of quantified items and descriptions (Hughes, 1978). It contains a schedule of fully described and quantified items of labor, plant, materials and other works which is set down in a systematic and recognised manner (Kwakye, 1997). Its purpose is not just to itemise construction work into component parts but to do this in such a way that a contractor is able to affix a price to the items (Hughes, 1978). The primary function of a BQ is to assist a contractor with the preparation of an estimate for tendering (Ashworth and Hogg, 2007; Lee, Trench, & Willis, 2005; Waterworth and Weddle, 1978). This function remains important though BQ may also aid in other aspects of contract management such as for interim valuations and final account (Ashworth and Hogg, 2007; Seeley, 1997; Waterworth and Weddle, 1978; Wilcox and Snape, 1980). Adequately prepared BQ offers construction projects and those involved in it with many advantages. According to Seeley (1997), a BQ reduces a contractor's estimating risks and tendering cost while to the client it provides a common basis for tender evaluation purposes. In addition, a priced BQ from a completed project is an excellent source for future estimating and provides readily available data for asset management, maintenance scheduling, taxation and insurance purposes (Davis,Love, & Baccarini,2009). A BQ also holds a key place in the flow of communication between the pre- and post-contract stages of a contract and is the only real communication connection between the client and the contractor (Laing, 1976). The BQ for a particular project involves the measurement or 'take-off' of quantities for various items of work from design drawings. The quantities are measured in accordance with a defined set of rules and

definitions known as a Method of Measurement. Measurement of quantities is a core skill which must be inherent in all graduates from QS courses (Laing, 1976).According to Pickens and Jagger (2005) measurement and quantification entails converting construction drawings into words and numbers in accordance with a strict set of rules. To be able to engage in measurement and quantification, quantity surveyor must have measurement skills, a thorough knowledge of building construction, acquaintance with the ordinary rules of measurement, knowledge of the customs of each trade, tact, patience, accuracy, energy, common sense,initiative,imagination to visualise building design details (Fortune &Skitmore, 1994, 1988) as well as the ability to write clearly, think logically and must possess a sound knowledge of building materials (Willis &Newman, 1988). Hodgson and Pyle (2010) add to the preceding list of skills by calling fo rthe ability to read and interpret drawings, methodical and tidy habits, the ability to cope with vast amounts of paperwork, curiosity, confidence and the flexibility to pick up useful information.

Having consulted the vast body of literature (Cottrell, 2008; Johnston, 2010; Bligh, 2000; Macfarlane, 2004), my sense is that QS students need the following competencies to be able to draw up the BQ:

- Reading and interpretation of engineering specific drawings, including identifying, collecting, processing and interpreting data and information for the evaluation and selection of appropriate procurement system and contractual arrangement; preparing tender and contract documents; administration of tendering processes; and, managing the implementation of construction contracts.
- Construction technology and engineering: knowledge of materials, plant, machinery and personnel in quantity surveying functions; cost and financial management, including project cost estimating and cost plans; preparing project budget and cash flows; administration of project cost and finance; carrying out feasibility and viability studies including collecting, preparing, analysing, and interpreting project cost and financial data and related information.
- Measurement and quantification of documents for project costing, measurement of quantities (a core skill of QS), cost planning and control, preparation of BQs, programme, resources planning and control, valuation for interim payment, and preparation of project account.

- Project management principles and practice regarding the provision of quantity surveying services and the management of project cost, finance, procurement and contract.
- Meta competencies such as being able to communicate effectively, high self-esteem, highly creative and innovative with problem solving ability, able to work in team, high ethical and moral value lifelong learning outlook.

I am of the opinion that in order to grasp the basic principles of measurement, traditional techniques are the ideal vehicle to acquire the basic skills. If students are not informed with these methods and introduced to computerised measurement systems in isolation, they may become blinded by technology and never grasp the basics. I advocate the use of computerised systems as a learning tool; however I feel that these should be introduced in parallel with traditional methods.

2.2.8 Reflective teaching practice

Reflective thinking is the process of making informed and logical decisions on educational matters, then assessing the consequences of those decisions. Campbell-Jones and Campbell-Jones (2002) describe reflection as an "inner dialogue with oneself whereby a person calls forth experiences, beliefs, and perceptions in order to inform and transform knowledge and action" (p. 134). Reflective teaching means looking at what you do in the classroom, thinking about why you do it, and thinking about if it works. In other words it is a process of self-evaluation.

Reflective practice is described by MacNaughton (2003 p. 12) as "an intellectually engaged activity geared to changing practices by transforming knowledge". The work of Grushka, McLeod and Reynolds (2005 p.7) describe reflective practice as a continuous process rather than a one-off event, involving "repeated cycles of examining practice, adjusting practice and reflecting on it, before you try it again". Reflective practice and critical reflective practice are features of high quality learning environments. The longitudinal findings of the Effective Provision of Pre-service teacher Education (EPPE) project (Sylva et al, 2004) found that high quality settings had positive effects on students' development both intellectually and socio-emotionally. The study also found the higher the quality of the learning environment, the better the outcomes for students (Sammons, 2010; Sammons, Smees, Taggart, Sylva, Melhuish, Siraj-Blatchford & Elliot, 2002). Further research concluded that students were found to make better all-round progress in settings where professionals were aware of students' individual learning styles; where educators had a good

understanding of appropriate pedagogical content and where there was a strong commitment to on-going professional inquiry (Siraj-Blatchford, Sammons, Taggart, Sylva & Melhuish, 2006).

Lasley (1992, p. 24) referred to reflection as the capacity of a teacher to think creatively, imaginatively and at times, self-critically about classroom practice. Norton (1994, p. 139) avers that reflection is a disciplined inquiry into the motives, methods, materials and consequences of educational practice. Reflection enables the teacher to thoughtfully examine conditions and altitudes which impede or enhance student achievement. It is also a way of thinking about educational matters including the ability to make rational choices and assume responsibility for those choices (Ross, 1989, p. 22). Through this decision making process, problems are identified, investigated and satisfactory answers are searched for.

My reflection will be focused on three main areas: (1) student engagement; (2) my teaching; and (3) contextual issues. I will be reflecting on the soundness of my teaching methodologies which will help me achieve the desired outcomes I outline in my lesson preparations. Regarding contextual issues, I will be reflecting on the lesson content that I deliver to learners in my class as to the extent to which the curriculum is enriched for my learners to have the necessary skills and competencies required in the workplace.

Thus, I have drawn on N4 QS students' engagement with assessing and processing information from engineering graphics and specification drawings to reflect on their learning and my teaching. By collecting information about what goes on in my classroom, and by analysing and evaluating this information, I have been able to identify and explore my own as well as N4 QS students' practices and underlying beliefs about assessing and processing information from engineering graphics and specification drawings. This may then lead to changes and improvements in teaching and learning.

2.3 Conceptual framework

The conceptual framework guiding this study embraces experiential learning theory (Kolb, 1984) as well as the model adapted by South African Survey of Student Engagement (Strydom &Mentz,

2010) originally designed by Kuh (2007, p. 11). I will fist discuss Kolb's ELT followed by SASSE model of student engagement.

2.3.1 Experiential learning theory

Experiential learning theory can be defined as "the process whereby knowledge is created through transformation of experience. Knowledge results from grasping and transforming experience" (Kolb, 1984, p. 41). Experiential learning theory depicts two dialectically related modes of grasping experience, concrete experience (CE) and abstract conceptualization (AC), and two dialectically related modes of transforming experience, reflective observation (RO) and active experimentation (AE). Experiential learning is a process that involves creating knowledge; immediate or concrete experiences are the basis for observation and reflections. These reflections are assimilated and refined into abstract concepts from which new implications for action can be drawn (Figure 1). These implications can be actively tested and serve as a guide in creating new experiences (Kolb, Boyatzis, & Mainemelis, 2000). Experiential learning can be portrayed as a cycle where the learner 'touches all bases', experiencing, reflecting, thinking and acting.

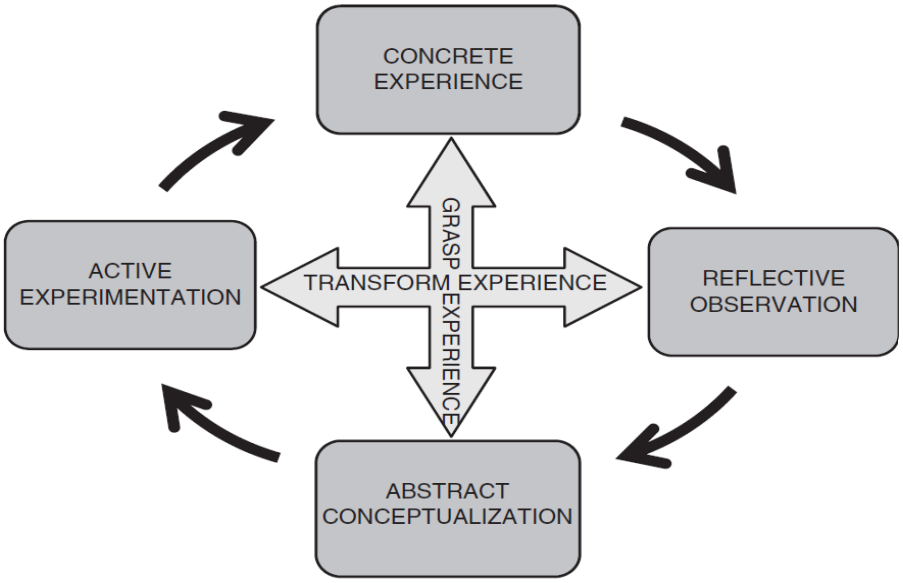


Figure 1: Experiential learning cycle
Source: Kolb and Kolb (2009, p. 299)

The ELT model suggests that learning requires abilities that are polar opposites, the learner having to choose which set of learning abilities he or she will use in a particular learning situation. In grasping experience some people distinguish new information through experiencing the concrete,

tangible, felt qualities of the world relying on their senses and engaging in concrete reality. Others tend to grasp new information through symbolic representation or abstract conceptualisation – thinking about, analysing and systematically planning rather than using sensations as a guide. Similarly, in transforming or processing experience some of people tend to carefully watch others involved in the experience and reflect on what happens, others choose to jump in and start doing things. The 'watchers' favour reflective observation while the 'doers' favour active experimentation (Kolb, Boyatzis, & Mainemelis, 2000).

Each learning dimension presents an individual with a choice since it is not possible for two learning styles to take place simultaneously. It is human nature to resolve by choosing in order to resolve the conflict between the different learning dimensions. Resolving the conflict between concrete or abstract and between active or reflective in some patterned way is referred to as 'Learning styles'. David Kolb developed the Learning Style Inventory in 1971 to asses individual learning styles. The Learning Style Inventory research instrument has identified four learning styles (Kolb 1984, 1999a, 1999b) namely: diverging, assimilation, converging and accommodation. . The diverging style dominant learning abilities are CE and RO. People with this learning style are best at viewing concrete situations from many different points of view. A person with the diverging style perform better in situations that require generation of ideas, such as a 'brainstorming' session. The assimilating style dominant learning abilities are AC and RO. People with this learning style are best at understanding a wide range of information and putting it into concise logical form. Individuals with an assimilating style are less focused on people and more interested in ideas and abstract concepts (Kolb, Boyatzis, & Mainemelis, 2000).

The converging style's dominant learning abilities are AC and AE. People with this learning style are best at finding practical uses for ideas and theories. They have the ability to solve problems and make decisions based on finding solutions to questions or problems. The accommodating style's dominant learning abilities are CE and AE. People with this learning style have the ability to learn from primarily 'hands-on' experience. They enjoy carrying out plans and involving themselves in new and challenging experiences.

Experiential learning theory provides a holistic model of the learning process and a multilinear model of adult development. The theory is called "experiential learning" to emphasise the central

role that experience plays in the process of learning. The term "experiential" is used therefore to differentiate ELT both from cognitive learning theories, which tend to emphasise cognition over affect, and behavioural learning theories that deny any role for subjective experience in the learning process. Experiential learning theory has its intellectual origins from the experiential works of Dewey, Lewin, and Piaget. Taken together, Dewey's philosophical pragmatism, Lewin's social psychology, and Piaget's cognitive-developmental genetic epistemology form a unique perspective on learning and development (Kolb, 1984).

2.3.2 SASSE Student engagement model

Student engagement represents both the time and energy students invest in educationally purposeful activities and the effort institutions devote to using effective educational practices (Kuh, 2001). Educationally effective institutions channel student energy toward the right activities. Active student engagement therefore requires that teachers actively seek to create the conditions that foster this reaction. This includes clear articulation of learning criteria with clear, immediate, and constructive feedback, showing students the skills they need to be successful. Student engagement is generally considered to be among the better predictors of learning and personal development. The premise is deceptively simple, perhaps self-evident: the more students study or practice a subject, the more they tend to learn about it. Likewise, the more students practice and get feedback on their writing, analyzing, or problem solving, the more adept they should become (Kuh, 2003). The very act of being engaged also adds to the foundation of skills and dispositions that is essential to live a productive and satisfying life after college. That is, students who are involved in educationally productive activities in college are developing habits of the mind and heart that enlarge their capacity for continuous learning and personal development (Shulman, 1986).

Most models that examine student success include five sets of variables: (1) student background characteristics including demographics and pre-college academic and other experiences; (2) structural characteristics of institutions such as mission, size and selectivity; (3) interactions with faculty and staff members and peers; (4) student perceptions of the learning environment; and (5) the quality of effort students devote to educationally purposeful activities.

I adapted the conceptual framework from the South African Survey of Student Engagement (Strydom & Mentz, 2010a) that was originally designed by Kuh,Kinzie,Buckley, Bridges,& Hayek (2007, p.11) for this study (see Figure 2).

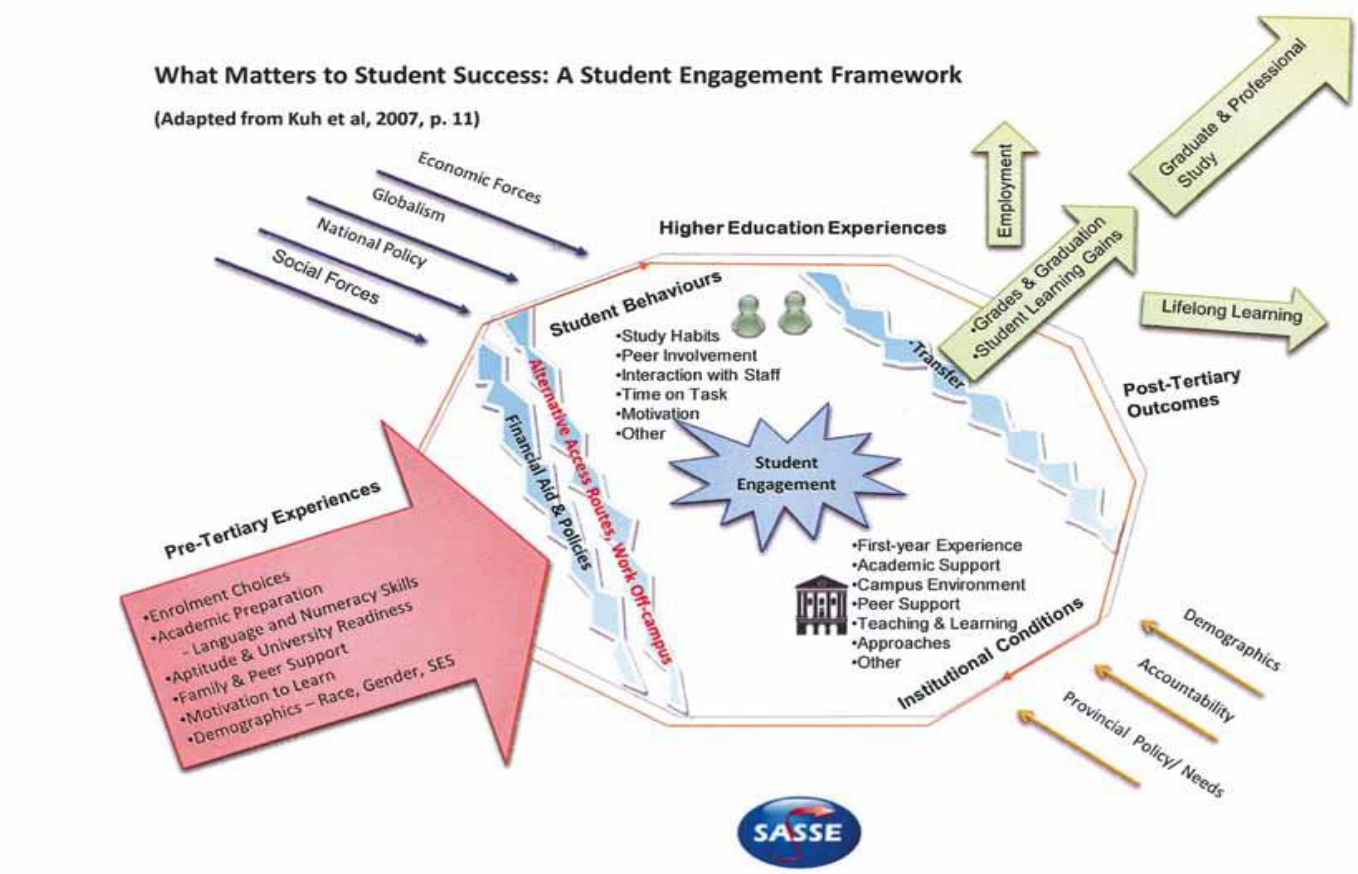


Figure 2: Student engagement framework
Source: Strydom & Mentz, 2010a p.10

There are many higher educational researches that assert that the best three predictors of student success are academic preparation, motivation and student engagement (Kuh, Kinzie, Schuh, & Whitt, 2005). A focus on student engagement offers institutions the opportunity to enhance the prospect for a diverse range of students, especially underprepared students, to survive and thrive in higher education (Strydom & Mentz, 2010a). This study focuses on particular aspects of the model, namely student behaviours and institutional conditions. The student behaviours focused on are motivation, learning of theory, response to teaching styles, collaboration learning (peer interaction) and staff interaction. Institutional conditions are related to attention to practical work,

time allocations, teaching and learning resources such as ICT and laboratory facilities and staff and tutor support.

A study on student engagement like this one requires investigating the environment in which teaching and learning take place because “institutional environments are important for student learning” (Kuh et al., 2005, p.8). The teaching and learning environment or context imbeds all influences that are external to the student and which have a direct or indirect impact on the way the student goes about learning.

2.4 Conclusion

In this chapter I presented the literature reviewed. The literature reviewed was aligned with the topic and research questions and focused on student engagement, sequencing of topics in the curriculum, teaching of EGD, learning styles and teaching styles while the interpretative paradigm requires the literature review to embrace reflective teaching practice. I have consulted literature pertaining to the teaching of EGD as there is a paucity of literature on the teaching of engineering graphics and specification drawings pertaining to QS. This is the gap that this study aims to address. Second an elaboration was provided on the conceptual framework. The conceptual framework comprises ELT and the South African Survey of Student Engagement(Strydom &Mentz, 2010).The next chapter discusses the methodology deployed in this study.

CHAPTER 3 : RESEARCH METHODOLOGY

3.1 Introduction

As mentioned previously this study sought to explore N4 Quantity Surveying students' engagement with engineering graphics and specification drawing. This chapter elaborates the methodological underpinnings of the study. A detailed description and explanation of the choice of paradigm, type of research and research design are offered. The types of instruments and methods used for data collection and analysis as well as the sampling technique employed and the rationale behind these choices are described. Steps untaken to ensure the validity and credibility of the research are made explicit. The steps taken to address the limitations encountered in this study and the ethical issues are explained.

3.2 Philosophical assumptions underpinning this study

According to Creswell (2012), a research paradigm is an approach or view that includes assumptions about the nature of knowledge, the nature of reality, the role of values and assumptions about research methodology. Therefore it is quintessential to clarifying the paradigm that a study adopts.

This research study is underpinned by the interpretivist paradigm. Cohen, Manion and Morrison, (2011), maintain that the interpretivist paradigm aims to understand and offer a detailed interpretation of the lived experiences and actions of participants in a study. As such, the interpretivist researcher seeks to understand as well as describe how people make sense of their worlds, how they make meanings of their actions and inactions. Resonating with the aforementioned ideas, Maree and Maree (2013) contend that interpretative studies aim to understand phenomenon through the meanings people assign to them Denzin and Lincoln (2011) posit that from an interpretivist perspective, human actions have meanings which are determinable by a researcher. Therefore, the interpretivist paradigm focuses on people's subjective experiences, on how people construct the social world by sharing meanings, and how they engage/relate with each other or a phenomenon. Additionally, Maree and Maree (2013) explain that the interpretivist

paradigm assumes that reality is socially constructed through the meanings people assign to the phenomenon under exploration. This means that placing people in their social contexts offers a better opportunity to uncover the perceptions they have of their own activities or engagements with the phenomenon under exploration. Therefore, the uniqueness of a particular context is crucial to understand and interpret the meanings constructed (Maree & Maree, 2013). Consequently, it is important to examine/explore situations through the eyes of participants rather than the researcher.

3.3 Research approach

The interpretative paradigm embraced in the study directed it towards a qualitative approach. According to McMillan and Schumacher (2010. p. 10) the goals of qualitative research are to "describe and explore" and to "describe and explain any phenomenon". In this study qualitative data was collected in order to gain a greater and deeper insight (Bertram, 2003; Kumar, 2005) into N4 QS students' engagement with engineering graphics and specification drawing. To access a deeper insight into N4 QS students' engagement with engineering graphics and specification drawing there needed to be room for flexibility at every stage of the research. Consequently, qualitative data was therefore deemed suitable because it allows for and captures a wide range of responses from observed situations and opinions of respondents.

3.4 Research design

The research design of a study is the plan of how the researcher will systematically collect and analyse the data that is required to give valid solutions to the research problem explored. This study adopts a case study design as a result of the ontological position of the interpretive paradigm (Creswell, 2013).

A case study is an in depth empirical inquiry approach that investigates a phenomenon within its real life context within a bounded system (Cohen et al, 2011). This means that context (real-life context) is a major factor in case study research methodology, because it gives the researcher the opportunity of interacting with the participants in their natural setting/context, thereby leading to in-depth understanding and interpretation of the phenomenon/case under investigation. The aim of a case study is to understand things in detail (Creswell, 2013). The case may be some aspects of the social life of a person or group of persons, an organisation or a phenomenon and it usually

generates words, rather than numbers as data for analysis (Lapan, 2012). The method allows participants to freely share their ideas, views, perceptions and experiences in their natural settings, making it possible for the participants to provide in-depth information/data (Cohen et al., 2013). The case study method is very suitable and useful when a researcher is seeking an in-depth understanding of a specific event, process, organisation or particular group/groups of people in a particular place. Furthermore, the case study approach answers the 'what', 'how' or 'why' of the phenomenon under investigation and also provides a detailed explanation of the phenomenon being explored by focusing on specific instances in a bounded system.

According to Lapan (2012), the hallmark of the case study approach is that it provides rich thick descriptions of participants lived experiences of, thoughts about, and feelings for, a situation using multiple data sources. It is descriptive and detailed with a narrow focus, and combines subjective and objective data. Put simply this means that it focuses on individual participants or group of participants and seeks for deep understanding of their perceptions of events. The researcher is integrally involved in the case since the case study may be linked to the personality of the researcher. The latter characteristic of a case study approach underlines the researcher's reason for the choice of this approach in the current study, considering that the researcher is integrally involved in the case under investigation as a result of the researcher's experience as a QS lecturer at the location of the study.

According to Creswell (2013) there are three different categories or types of case study approaches which a researcher can choose from. These categories are distinguished by the size of the bounded case, that is whether the case involves one individual, many individuals, a group of individuals, a process, an institution or an activity. The categories of case studies are:

- **Intrinsic case study:** These are studies undertaken in order to understand the particular case at hand (Cohen et al., 2013, p. 291). According to Lapan (2012), an intrinsic case study focuses on the case being studied, answering questions about that entity or object in order to convey the illuminated operations to its participants and stakeholders. Here, the purpose is not to understand some abstract generic phenomenon, but to develop a detailed understanding of, and insight into, a particular case at hand.

- **Instrumental case study:** This examines a particular case or instance to build new theories or to compare previous findings to new ones for corroboration or to question their validity (Lapan, 2012). The case here is of secondary interest, which is facilitating of theory.
- **Collective case study:** This involves studying a number of cases (multiple case studies) jointly in order to investigate a phenomenon (Creswell, 2013). This method is believed to offer better understanding of the phenomenon/case.

In another classification of case study research approaches, Yin (1994) identified three categories of case studies with regards to their outcomes. These include:

- **Exploratory case study**: This serves as a suitable means of eliciting information in order to seek new insights and clarify one's understanding of a process or problem. This approach also serves as a pilot to other studies or research questions. This implies that the exploratory approach provides new and detailed information or insight about a problem or a process (phenomenon) through the research findings, which can perhaps inform policy or serve as the background for further research.
- **Descriptive case study:** This type of case study focuses on providing narrative accounts.
- **Explanatory case study:** This deals with hypothesis testing.

As a result of critical consideration of the above categories or types of case studies, I chose the exploratory case research study methodology. The choice of exploratory case study method is based on the purpose or intent of the study which is to explore N4 QS students' engagement with engineering graphics and specification drawing.

Whilst a case study design has many advantages, it also has limitation. According to Maree and Marree (2013) the dependence on a single case makes it incapable of generating generalisable conclusions; the samples are usually small and often not necessarily representative of the broader population so it is difficult to know how far one can generalise the result; and it is difficult to tell how far the findings are biased by the researcher's own opinions.

3.5 Location of study

The study was located at the XY College (XYC) which is located at 375/384 Anton Lembede Street, Durban, Kwa-Zulu Natal. The XYC has been in existence for the past 25 years. The college has a well-equipped library, computer laboratories, physical science laboratory, civil, mechanical and electrical engineering workshops as well as lecture halls and classrooms.

The college offers two streams of academic programmes. The first stream offers tuition to grades one to eleven in English, Afrikaans, mathematics, physical sciences, accounting, economics, and tourism. The second stream offers tuition at a tertiary level, namely, diplomas (level N4-N6) in civil, mechanical and electrical engineering, information technology, public administration, accounting, catering, hospitality and tourism. The academic teaching staff are all qualified graduates. The XYC attracts one thousand students per year who are representative of the rainbow nation (that is African, Indian, Whites and Coloureds).

Data collection

Data collection methods are tools used by a researcher to collect data as required in order to answer the relevant research questions. In this section I discuss issues pertaining to gaining access, instruments used, sampling methods, phases of data collection, how data was analysed as well as how issues of trustworthiness, validity and reliability were addressed.

3.5.1 Gaining access

Gaining access means dealing with various gatekeepers at each stage of the research. Formal permission to conduct research was obtained from UKZN's research office as well as XYC. Permission was also obtained from the N4 QS student participants during each phase of data capturing. Whilst collecting data I realised that gaining access is an iterative process for each level of data collection.

3.5.2 Data collection instruments

The following instruments were used to capture data to answer the two research questions posed: a task based activity, individual interviews, focus group interviews, collage making and concept mapping. The above-mentioned instruments were used because they were the most suitable instruments for collecting qualitative data and gaining an in-depth insight into N4 QS students' engagement with engineering graphics and specification drawing.

3.6.2.1 Task based activity

The paper-and-pen test (see Appendix A5) was designed and developed by the researcher in accordance with the N4 QS curriculum stipulated by DBE. All questions posed were in English according to the XYC language policy. Individual items in the test were designed or adapted by the researcher to comply with the requirements of this study (students' engagement with with engineering graphics and specification drawing). This test consisted of three questions, based on the N4 QS curriculum.

The test items were created and selected in such a way that no knowledge beyond what lay within the reach of the N4 QS curriculum was required. The duration of the test was one hour. The test was piloted in two ways. A pilot study serves to increase the reliability, validity and practicability of the task based activity (Cohen et al., 2011). The test was first piloted with N4 QS lecturers from ABC TVET College to check if the test complied with the N4 QS curriculum. Second it was piloted with N4 QS students from ABC TVET College to check the clarity of the questionnaire items, and eliminate ambiguities or difficult wording. The outcome of the piloting indicated that the questionnaire items had good construct validity. Minor changes were made to the wording of certain questions to improve readability.

The rationale for starting data collection with the task based activity was to allow participants the opportunity to answer the questions privately, with information written down in their own words. This reduced the possibility of the researcher misinterpreting information and then misrepresenting it in the field notes.

The test was administered to N4 QS students during a lecture period.

3.5.2.2 Individual interviews

Interviews are a major data generation method in research. A research interview is defined by Cohen and Manion (1980) as a two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information. Cohen et al. (2007) define an interview as an interchange of views between two or more people on a topic of mutual interest. Interviews range from structured interviews to semi-structured and informal unstructured interviews.

Structured interviews conform to a set range of questions with the responses fall into parameters predefined by the interviewer. Unstructured interviews involve questions which are developed from the immediate context, with the interview taking on a more conversational stance.

The semi-structured interview is highly favoured in educational research. A semi-structured interview (see Appendix A6 for semi-structured interview questions) was used as the second data generation instrument as it allowed the researcher to further probe participants' responses to the task based activity. According to Hesse-Biber and Leavy (2011) a semi-structured interview provides valuable information arising from the context of the participant's experience, because it does not limit the respondent; it allows for probing of responses and encourages elaborate responses.

In explaining a semi-structured interview, also referred to as informal interviews, Longhurst (2010, p. 35) expresses the view that "interviewing is about talking, but it is also about listening. It is about paying attention. It is about being open to hear what people have to say. It is about being non-judgmental. It is about creating a comfortable environment for people to share". The interview was semi-structured in that respondents were asked questions in the same order, and in this way it served the purpose of sampling the respondents' responses and thereby increasing comparability of responses (Cohen et al., 2011). In accordance with the suggestions advocated by Longhurst (2010) the following issues were taken into account during the interviews:

- Establishing rapport and trust with the interviewee;
- Empathy and neutrality;
- Using non-verbal nods and verbal "um-hms" to show interest;
- Monitoring yourself;
- Sensitivity towards gender and cultural differences;
- Providing sufficient time for the interviewee to respond; and
- Maintaining control of the interview and keeping the interview focused.

The interview questions were six and focused on the rationale behind students answering questions in the task based activity the way they did. All interviews were videotaped.

3.1.2.3 Collage

Collage making is a "creative arts-based method in which separate images are cut from magazines, news articles and/or books and glued together to create a new image" (Raht, Smith, & MacEntee, 2009, p. 229).This is a "process of using fragments of found images or materials and gluing them to a flat surface to portray the phenomena" (Butler-Kisber & Poldma, 2010, p. 2). The use of art as a data generation method is something on the rise in qualitative research (Mayaba & Wood, 2015; Theron, Mitchell, Smith & Stuart, 2011). Using art as a research method provides researchers with a window into the lived experiences of the participants and a means to understand how they make meaning of these experiences; they also provide a powerful intervention to engage participants in the construction of alternative realities (Mayaba & Wood, 2015). Collages or rather the images in the collage allow for access to different levels of consciousness, many conversations with the 'self' and 'other' thereby communicating a holistic picture of 'what is' or the reality of an experience (Prosser & Loxley, 2008). I provided the students with a wide variety of magazines from which to source pictures and text for their collages.

By engaging in collage making N4 QS students had to position themselves, their encounters, experiences with regard to their engagement with engineering graphics and specification drawing in the collage. Each chosen picture tells a story about their experiences pertaining their engagement with engineering graphics and specification drawing.

To create the collages N4 QS students sat in a group (comprising five students) and collectively looked through magazines, newspapers, catalogues for pictures and words (Khanare, 2009). Originally my intension was to have two groups of students creating collages, but due to issues of informed consent only five students participated in this study. Therefore, only one collage was created. The intention of this exercise was or participants to choose pictures or images that best captured their experiences of their engagement with engineering graphics and specification drawing well as the factors that impeded or promoted their engagement with engineering graphics and specification drawing. They also cut out words and sentences that added to what they aimed to articulate through their collages. As a group, they had to look at images chosen by each member of the group and collectively make choices based on which ones best spoke to what they wished to express of their experiences of engagement with engineering graphics and specification drawing. N4 QS students then collectively created the collage as they negotiated and debated over the construction of the collage.

3.6.2.4 Concept maps

After making collages N4 QS students were exposed to the construction of a concept map extracted from their collages. Concept mapping is a form of art based research. Concept maps are described by Novak and Cañas (2008) as graphical tools for organizing and representing knowledge. Wheeldon and Faubert (2009) describe concept mapping as a technique that can demonstrate how people visualise relationships between various concepts, and therefore provide a visual representation of dynamic schemes of understanding within the human mind. Concept maps allow for a synergy to exist between more mainstream data generation methods which are word based, and thematic data generation methods such as collages (Jackson & Trochim, 2002). This integrated approach allows abstract concepts to be more concretely visualised while keeping the freedom and expressive insight one hopes to get from qualitative research. Jackson & Trochim (2002) go on to describe concept mapping as an informal process whereby an individual draws a picture of all the ideas related to some general theme or question and shows how these are related. The resulting map usually has each idea in a separate box and the boxes are connected by connective terms to show how they are related. For the purpose of this study, concept maps were useful a way in which participants could demonstrate their belief in the importance and commonality between different concepts and the nature of perceived relationships (Wheeldon & Faubert, 2009).

The group of students transcribed meanings from their collages into concept maps. The main images from the collages were numbered consecutively and thereafter, the sets of related concepts were grouped together. This allowed N4 QS students to represent an understanding of relationships between important sets of concepts.

3.6.2.5 Reflective diary

Maintaining a self-reflective diary is a strategy that can facilitate reflexivity, whereby researchers use their journal entries to examine "personal assumptions and goals" and clarify "individual belief systems and subjectivities" (Russell & Kelly, 2002, p. 2). Keeping a reflective journal is a common practice in qualitative research (Etherington, 2004). A reflective diary helped me keep track of the ideas, experiences, learnings, changes and evolution I underwent during the research process and my teaching of engineering graphics and specification drawing.

3.7 Sampling

Cohen et al. (2007), refer to sampling as a process of decision-making about the population (community), settings, events or deeds that have been chosen for exploration. Both convenience sampling and purposive sampling were used for the study. According to Maree and Maree (2013) convenience sampling occurs when the site or respondents are selected on the grounds of proximity and affordability. The location for the study is conveniently selected as I am employed as a QS lecturer at XYC. Johnson and Christensen (2008) maintain that purposive sampling occurs when the researcher specifies the characteristics of a population of interest as they have the data. The participants for this study were purposively selected as they were pursuing the N4 QS course at XYC. There are six students enrolled for the QS N4 module in my class and five of them consented to participate in this study.

3.8 Data generation plan

Table 1 shows the four phases in data collection, related to the data source, the instrument used, the research question in focus, and the purpose of the phase.

Table 1: Data generation plan

Research question	Phase	Data source	Instrument	Purpose of phase
How do N4 QS students' engage with the assessing and processing of information from engineering graphics and specification drawings?	1	N4 QS students	Task based activity	To establish how students engage with assessing and processing information from engineering and graphics and specification drawings
		Self (researcher)	Reflective journal	To record my experiences, observations, emotions, evolutions that occur during the research process
Why do N4 QS students engage with the assessing and processing information from engineering graphics and	2	N4 QS students	Interview	To probe why QS students engage with the assessing and processing information from engineering and graphics and specification drawings the way they do.

specification drawings the way they do?		Self (researcher)	Reflective journal	To record my experiences, observations, emotions, evolutions that occurred during Phase 2 of data generation
What factors promote or impede N4 QS students' engagement with the assessing and processing of information from engineering graphics and specification drawings?	3	N4 QS students	Collage making Concept map	To establish factors which promote or impede N4 QS students' engagement with assessing and processing information from engineering and graphics and specification drawings
		Self (researcher)	Reflective journal	To record my experiences, observations, emotions, evolutions that occurred during the research process

Table 1 indicates the three phases of data collection which are explained as follows.

3.8.1 Phase 1

As an entry point into the study, during phase 1 of data capture, N4 QS students were exposed to a task based activity on assessing and processing information from engineering and graphics and specification drawings (see Appendix A5 for task). The task was marked according to the rubric (see Appendix A5 for memorandum and written feedback was provided to the students for each question. I maintained a reflective journal while designing and marking the task based activity.

3.8.2 Phase 2

Students were presented with their marked task based activity, thereafter they were interviewed individually to ascertain their rationale for their responses to the task based activity and then collectively in a focus group discussion. The interview was video recorded as it captures the non-verbal data such as facial expression and body language that will not be captured in an audio recording. The interviews were transcribed and then sent to the participants for member checking before analysis. I recorded my reflections in my reflective journal.

3.8.3 Phase 3

During Phase 3 of data collection participants were asked up to develop a collage from the magazines provided working together as a group. They were instructed on what a collage is and how to make a collage. A collage is a collection of pictures/images that represent feelings and experiences about a situation (Threadgold, 2003). Collages/images allow for access to different levels of consciousness, many conversations with the 'self' and 'other' thereby communicating a holistic picture of 'what is' or the reality of an experience (Prosser & Loxley, 2008). Participants were asked to reflect on their engagement with engineering graphics and specification drawings and to identify factors that promoted and/or impeded their engagement with assessing and processing information from engineering graphics and specification drawings. By engaging in collage making students had to position themselves, their encounters and their experiences in the collage. Each chosen picture told a story about their experiences pertaining to learning engineering graphics and specification drawings. Concept maps were developed from their collages. Concept maps are graphical tools that organise, connect and force the researchers/participants to synthesise information between important sets of concepts (Kilic & Cakmak, 2013). Concept maps are useful in eliciting and assessing understandings of an issue under study.

3.9 Data analysis method

As mentioned previously this study embraced a qualitative case study approach, therefore analysis of data also involved a qualitative approach. According to Cohen et al. (2011) analysis of data entails breaking down the information collated into elements in order to obtain responses to research questions. Put simply this means that analysis entails categorising, ordering, manipulating and summarising the information achieved in responses to research questions (De Vos, 2002). The intention of analysis is therefore to transform data to an interpretable and understandable form, so that relations of research problems can be studied and tested in order for conclusions to be drawn (De Vos, 2002).

According to Cohen et al. (2011), analysis of qualitative data involves organising, accounting for and explaining the data in terms of the participants' experiences of the phenomenon being explored, noting patterns, themes and categories and regularities. Data from the three phases of this study were analysed by a deductive approach. Deductive analysis involves a systematic procedure for analyzing qualitative data where the analysis is guided by specific objectives (Cohen

et al., 2011). Using this approach, all the relevant data from different sources are collated to provide a collective answer to a research question. In this study N4 QS students are the unit of analysis and the phenomenon being explored is their engagement with engineering graphics and specification drawings.

During Phase 1 of data analysis the task based activity was marked as per the attached memo (see Appendix A5). The overall trends in students' performance were note. To safeguard the identity of the participants (N4 QS students) involved, codes were used when referring to participants. All participant codes start with **S** (for student), followed by a number, thus, **S1-S5**.

The overall trends in students' performance for the three questions were noted as follows correct response, response partially correct, response provided incorrectly and no response. The approaches used to answer the question were also classified and written feedback was provided to students.

During Phase 2of data analysis the interview transcripts were read several times to embark on content analysis. Content analysis, according to Cohen et al. (2011), is a systematic set of procedures for rigorous analysis, explanation and verification of the content of written data. It is a technique for making replicable and valid inferences from text to the contexts of their use. The responses were read several times before coding of the open ended questions could begin. Codes sharing the same characteristics were grouped into categories and finally categories emerged from the data.

During Phase 3 of data analysis, data from the collage and concept maps were analysed via content and thematic analysis.

3.10 Research rigor

Every research study is subject to an open critique and evaluation. Without this, the soundness of its methods, accuracy of findings, the quality of assumptions made and conclusions reached are questionable and could reduce the value of the stud, (Long & Johnson, 2000, p. 30). Results of data collected and analysed in my study were exposed to criticisms from other researchers in the field of study. Nevertheless, I indicate below how this research has been designed to avoid or minimise challenges to its validity.

3.10.1 Validity

Validity is a term used in qualitative research, which indicates whether the researcher is actually carrying out the research as proposed. It is achieved through a consistent check on the research instrument for objectivity, and the data for consistency. Ensuring objectivity is not an abstract activity; rather, it should dictate all efforts undertaken to ensure that the research evidence does back up the research claims (Silverman, 2010, p. 366). Because qualitative data does not allow for statistical testing, in qualitative research significant attention is given to internal validity. In this regard, Yin (2008) recommends that different responses from participants in the group be checked for consensus. In other words triangulation is needed, as explained in Section 3.10.5. Further, to achieve internal validity, methods such as pattern matching, explanation building, logic models, or addressing conflicting descriptions are used. As stated by Amerson (2011, p. 428) "construct validity can be achieved using several sources of evidence, sustaining an arrangement of proof, and having a key informant review the draft of the case study report, or through member checking". Consequently, in this study, construct validity necessitated having several sources of evidence. All video recorded interviews were kept safely and reviewed during analysis to avoid uncertainty. Furthermore, during the focus group discussion, I asked participants for clarity where there were divergent views in order to ascertain a consensus response which helped to achieve internal or construct validity.

Furthermore, many researchers in qualitative research submit that to evaluate and ascertain the quality of a qualitative research work, terms such as trustworthiness, relevant, confirmable, credible, dependability, transferability or plausible are used (Denzin & Lincoln, 2005, p. 24). Accordingly, to enhance the worth of my research I have adopted the notion of credibility as well as internal or construct validity.

3.7.2 Credibility

In order to ensure credibility of my study, data was generated to ensure detailed description of the settings, participants and themes of my study, as recommended by Creswell & Miller (2000, p. 128). These aspects are discussed next.

Triangulation: Triangulation is a process used to ensure credibility in a research study. Data from the three phases of data generation were juxtaposed in order to build a coherent justification for the interpretations and conclusions arrived at.

Member checking is a research procedure used to ensure credibility and validity of the research. According to Carlson (2010), member checking involves asking participants to review the interview transcript or particles from the narratives/accounts they contributed during interview sessions to check their accuracy. In this process participants were given the opportunity to elaborate, clarify or confirm aspects of the interview in order to ensure that their views, experiences and perceptions were captured accurately during the interview. Thus, member checking was adopted for the transcripts of the interviews and the think-aloud protocols to guarantee the credibility of the research.

Rich thick descriptions were used to convey the findings. These descriptions may transport the reader to the setting and give the discussion an element of shared experience.

Anonymity: All participants in the study were assured of the anonymity of their identity before and after the data collection to enable them to partake willingly and freely in the research. Again, this was to also to guarantee strict adherence to the University's research ethical standards.

3.11 Limitations of the study

This is a case study so the findings may not necessarily be generalised but rich thick descriptions will be provided during data analysis so that the findings of this study can be applicable to similar contexts in South Africa.

As this is a case study and sampling was purposive, the results of this study should not be generalised. Nevertheless, as mentioned previously in Section 1.5, a single case study can be regarded as valid, as was the case with Newton and Gailileo. The case study method allows for an in-depth and detailed study N4 QS students engagement with engineering graphics and specification drawings.

3.12 Conclusion

The researcher used a qualitative, case study research design. The researcher used a task based activity, semi-structured interviews, focus group discussion, collages and concept maps as instruments to collect data from a convenient sample of five respondents. The sample characteristics included N4 QS students who were enrolled at XYC. Formal permission was obtained from UKZN ethics office and XYC to conduct the study. Informed consent was obtained from the N4 QS students themselves. Anonymity, self-determination and confidentiality were ensured during data collection and report writing. Transcripts of the interview and focus group discussion were distributed to respondents to ensure validity. Data from the three phases of data collection was triangulated in order to increase reliability.

This chapter described the research methodology, including the population, sample, data collection instruments as well as strategies used to ensure the ethical standards, reliability and validity of the study. The next chapter presents the findings and discussions.

CHAPTER 4 : PRESENTATION OF FINDINGS AND DISCUSSION

4.1 Introduction

This chapter sets out to present data so as to answer the three research questions posed, namely: (1) How do N4 QS students' engage with the assessing and processing of information from engineering graphics and specification drawings? (2) Why do N4 QS students engage with the assessing and processing of information from engineering graphics and specification drawings the way they do? (3i) What factors promote or impede N4 QS students' engagement with the assessing and processing of information from engineering graphics and specification drawings? As alluded to in Chapter 3, data was collected via a task based activity, interviews, focus group discussion, collages and concept maps. This chapter is divided into three parts, A, B and C. Part A focuses on the task based activity in an effort to answer Research Question 1. Part B aims to answer Research Question 2 while part C proposes to answer Research Question 3.

4.2 Part A: Research Question 1

As mentioned previously in Chapter 3, in order to answer Research Question 1 (How do N4 QS students engage with the assessing and processing of information from engineering graphics and specification drawings in order to prepare a bill of quantity?) students engaged in a task based activity (see Appendixes A5 and A7) and I engaged in reflection.

4.2.1 Task based activity

The task based was marked according to the memorandum (see Appendix A5). Table 2 reflects the marks of S1 to S5 in the task based activity in percentage (see Appendix A7 for individual responses of participants to task based activity). As already alluded to in Chapter 3 (Section 3.9) participants were coded S1-S5.

Table 2: Participants marks in percentage for task based activity

Participants	% acquired in task based activity
S1	62
S2	23
S3	44
S4	39
S5	43

As can be noted from table one above, only S1 scored more than 50% in the task based activity. This means that four students (S2-S5) did not pass the task based activity and are encountering problems with preparing a BQ. In order to further understand N4 QS students' engagement with the task based activity the overall trends in students' performance were noted in respect of correct response, response partially correct, response provided incorrectly and no response and are reflected in Table 3 (see Appendix A7 for participant responses to task based activity).

Table 3: N4 QS Students' responses to the task based activity

No.	Question Requirement	Correct response	Partially correct response	Incorrect response	No response
1.1.	**Wrote title of project out building on dimension paper**	S3			S1; S2; S4; S5
	Provided the 10 pointchecklist for taking off	S1; S3; S4; S5			S2
	Described nature of work to be done and quality of materials to be used accurately for the 10 measuring items of the foundation				
	Site clearance		S4; S5	S1; S2; S3	
	Excavation of surface trench	S5; S3		S1; S2; S4	
	Risk of collapse (ROC) to sides of trenches			S1; S2; S3; S4; S5	

	Risk of water	S1; S2; S3; S4; S5			
	15 MPa concrete in surface trench concrete		S2	S1; S4; S5; S3	
	One and half brick wall			S1; S2; S3; S4; S5	
	Back fill	S3; S5	S1, S2; S4		
	Cart away soil	S1; S2; S3; S4; S5			
	Hard core fill under surface bed	S1; S3; S5	S2		S4
	Extra over ordinary bricks for external facing		S1	S4; S5	S3; S2
	Made accurate assessment of engineering graphic and specification drawing and measured 10 foundation:				
	Site clearance	S1; S3; S4; S5			S2
	Excavation of surface trench	S1; S3	S2; S5	S4	
	Risk of collapse to sides of trenches	S1; S4	S3; S5		S2
	Risk of water	S3; S4; S5			
	15 MPa concrete in surface trench	S1; S2; S4; S5		S3	
	One and half brick wall	S3; S4	S1	S5	
	Back fill	S1	S2; S4; S5		S3
	Cart away surplus soil	S1	S3	S2	S4; S5
	Hard core fill under surface bed	S1; S5	S2		S3; S4
	Extra over ordinary bricks for external facing		S4; S5	S1	S2; S3
	Wrote pages 1 and 2 on dimension sheet	S4; S3; S5			S1; S2;
1.2.	**Squared the 7 earthwork trade items accurately on dimension paper**	S1	S3; S4	S5	S2

	Wrote title of project 'outbuilding' on the abstract paper	S3; S4		S1	S2; S5
	Wrote trade name 'Earthwork' on the abstract paper	S3; S4		S1	S2; S5
	Abstracted the 7 Earthwork trade items successfully	S1	S3;	S4; S5	S2
	Made accurate referencing of all the 7 earthwork trade items		S3; S4; S5	S1	S2
	Wrote title of project 'Outbuilding' on dimension paper	S3		S1	S2; S4; S5
	Wrote name of trade 'Earthwork' on billing paper	S1; S3; S4			S2; S5
	Wrote "Bill no. 1' on billing paper	S4		S1	S2; S3; S5
	Wrote all Earthwork items in their right order, with reduced quantities and units		S3; S5	S1; S4	S2
	Carried Bill no.1 to summary	S4		S1	S2; S3; S5
2.1.	Made accurate sketch through head, top rail, fanlight and soldier arch of casement window			S1; S3	S2; S4; S5
2.2.	Made accurate sketch through the transom and surrounding constructions			S1; S3	S2; S4; S5
3.1.	Stated 5 functions of the quantity surveyor	S1; S2; S3; S4; S5			
3.2.	Described chronologically the processes involved in preparing the bill of quantities	S1; S3	S2	S4	S5
3.3.	Stated the rule of abstracting as they appear in the latest edition of the Standard System of measuring builder's work in South Africa,	S1	S2	S4	S3; S5

A closer examination of Table 3 reveals that for Question 2 of the task based activity all participants scored zero. Question 2 was designed to test N4 QS students understanding of practical construction procedures.

An analysis of participant S2's responses to the task based activity reveals that S2 encountered difficulty with reading and interpreting the questions posed in the task. This observation would be probed further during the interview in Phase 2 of data generation. In effect this meant that S2 was unable to identify, collect, process and interpret data and information for the evaluation and selection of appropriate procurement system sand contractual arrangements from the engineering specification drawing. Further, S2 was unable to recall initial information required to create a check list to measure a foundation. Thus, S2 cannot transfer or apply information from one task to the next. In terms of my conceptual framework, namely, Kolb's ELT (1984), it is evident that S2 remains stuck at the concrete experience phase and does not move along the continuum to the level of abstract conceptualisation. In other words facts/content pertaining to QS are learnt as unrelated issues or ideas and in isolation. As a result of learning ideas in isolation and being unable to transfer/apply information to another situation, his/her measurements for the foundation are incorrect/incomplete and in some instances absent (left out totally).S2's calculation of material required are also incorrect, confirming his/her inability to transfer/apply knowledge. S2 seems to have difficulty in performing simple calculations. Additionally, S2 cannot read and interpret the engineering graphics specification drawing to access the information needed to prepare the bill of quantities.

A closer look at participant S3's responses to the task based activity shows that S3 was able to read and partially interpret the engineering graphics and specification drawing. Consequently, participant S3 was unable to perform accurate measurements (such as backfill to side of trenches, cart away surplus soil from site, ROC and had very little knowledge about analysis of construction details. Hence S3 was unable to correctly access and apply the information required to prepare the BQ from the descriptions that were provided by him/her as they were incomplete. Even S3's knowledge of materials, plant, machinery and personnel in quantity surveying functions, cost and financial management, including project cost estimating and cost plans, preparing project budget and cash flows, carrying out feasibility and viability studies including collecting, preparing,

analysing, and interpreting project cost and financial data and related information is limited. It is evident from S3's responses to the task based activity that S3 does not engage in reflection nor does S3 act in a cyclic process in response to the learning situation and what is learnt. It can thus be concluded that S3 is functioning at the concrete level of Kolb's ELT and has not progressed to the other levels as yet.

An examination of participant S4's responses to the task based activity demonstrates that S4 has difficulty in reading, interpreting and abstracting information from the engineering graphics specification drawing. As a result S4 provided descriptions that were incomplete and not compliant with the recommendations of the standard system of measuring building work in South Africa. As per Kolb's (1984) ELT, S4 is also stagnant at the concrete level and cannot progress to the other three levels of Kolb's (1984) ELT. Over and above these challenges, S4 is not familiar with groupings found in the standard system and incorrectly places non-earthwork items like concrete and masonry brickwork in the earthwork trade abstracts. Furthermore, S4 encounters several challenges with measurements (such as extra over excavation for cart away, extra over ordinary bricks for external facing, perimeter, squaring, incorrect order of writing dimensions). Such errors in the world of work would impact the profit margin of a construction company.

Scrutinizing participant S5's responses to the task based activity highlights that S5 has difficulty in accessing information from the engineering graphics specification drawing. Like S2, S5 encounters challenges in identifying, collecting, processing and interpreting data and information for evaluation before the BQ can be prepared. Due to the preceding lack of ability S5 omits the crucial strength of concrete in his descriptions. Such an error impacts the safety of the structure and the integrity of the construction company. The descriptions provided by S5 are incomplete and not compliant with the standard system of building work in South Africa. S5 also makes numerous squaring errors which render the processing of information on the abstract and billing sheets incorrect. The squaring errors made by S5 expose his/her lack of processing skills when interpreting engineering graphics and specification drawings.

According to Chan (2012) Kolb's (1984) ELT model contends that effective learning requires four different abilities; CE skills, RO skills, AC and AE skills. The CE stage requires the learner to be immersed in the new learning experience, relying on their intuitive and affective responses to immediate situation (Bergsteiner & Avery, 2014). It is obvious that the participants (S1-S5) of this

study were not immersed in and did not fully and effectively engage with engineering graphics and specification drawings during their lectures, simulations and tutorials. Hence they were unable to progress to the RO stage, which comes into play when the learner consciously reflects and draws conclusions on their gained experience through thought questions, brainstorming, discussion and personal journals (Bergsteiner & Avery, 2014). The progression from one stage to the next in Kolb's ELT model demands a tentative, impartial perspective towards a learning situation. Progression of learners to the AC stage calls for logical thinking and rational evaluation in order to create ideas that integrate their observations into logically sound theories (Bergsteiner & Avery, 2014). At the AC stage, the learner conceptualises a theory, a model, a project or analogies and utilises these generalisations as guides to be able to analyze, extrapolate, evaluate and take risks in learning (Kolb, 1984; Chan, 2012). It is in the AC stage that the learner engages in further action, experiments with different scenarios, and uses the theories generated to make decisions and solve problems leading to new experiences.

Judging the responses of all five participants (S1-S5) to the task based activity it can be inferred that they all lack competencies such as being able to communicate effectively, be innovative with problem solving ability, use the theories generated to make decisions and solve problems leading to new experiences, and are static in the CE stage.

From a methodological perspective, Kolb's (1984) theory has been used to highlight the kind of engineering graphics and specification drawing experience/skills N4 QS students require to be able to function as QSs. The theory can further explain what N4 QS students require to reflect and draw conclusions on, to have actual real-world experiences that are needed in the industry and other places of relevance.

4.2.2 Reflections

As outlined in Chapter 3myreflection focused on three main areas: student engagement, my teaching and contextual issues (see Table 4) (see Appendix A10 or detailed reflection).

Table 4: Summary of my reflections

Area	Reflection
Student engagement	• Motivation and commitment • Absenteeism • Teaching in vein
My teaching	• Delivery of measurement modules • What is challenging for me
Contextual challenges:	• N4 QS course is of 3 months duration, students lack a technical background, a minimum pass of 30% in mathematics and physical sciences is required for admission to QS

The three reflection areas summarised in Table 4 will be discussed next.

4.2.2.1 Student engagement

Student motivation levels and commitment to their studies is of grave concern to me as is their high absenteeism from lectures. I often imagine that they do not make a concerted effort to learn and that all the effort I put into my teaching is in vein. I often feel demotivated with the students' poor performance in the learning tasks.

4.2.2.2 My teaching

In the delivery of measurement modules I used traditional lectures as well tutorials. The tutorials provide the students with an opportunity to apply new knowledge gained during lectures, by means of measuring quantities from various drawings which are provided, giving students a flavour of workplace practice. However, the applied measurement carried out during these tutorials was in the majority of cases manual in nature. The method of delivery favoured by me focused on traditional manual measurement techniques. I foreground the following traditional measurement skills and competencies in my lectures: acquaintance with the ordinary rules of measurement, knowledge of the customs of each trade; patience, accuracy, common sense, initiative, and imagination to visualise building design details, the ability to write clearly, thinklogically and possess a sound knowledge of building materials. I concur with Hodgson and Pyle (2010) that a good basic numerate education is invaluable, along with site experience, ability to read andinterpret drawings, a neat, methodical and tidy habit, ability to cope with vast amounts

ofpaperwork, curiosity, confidence and the flexibility to pick up useful information.The skills and competencies outlined above are consistent with traditional practice, and areenshrined in traditional modes of delivery for this subject. Maybe I need to provide opportunities for students to do small group brainstorming before they can commence with an activity or I should lecture for a shorter duration and have more learner centered activities. I should also consider assuring students that their academic difficulties can be overcome and be more readily available for consultation time with my students.

My challenges are pitched at two levels: at a teaching/learning level and at a contextual level. What is challenging for me at a teaching level, is not just teaching about measurements but rather trying to ensure that students have sufficient knowledge and understanding of construction technology to enable them to measure. An in-depth knowledge of measurement technique will be inadequate if the student does not possess a technical knowledge and understanding of building or civil engineering technology. Additional dilemmas that I encountered during my lectures were how do I used traditional lecture methods to teach my module to students who are citizens in an information technology era? And what pedagogical changes do I need to undertake to meet the needs of my cognitively diverse students who learn in different ways? How do I begin to know the diverse learning styles of my students as I am a qualified quantity surveyor with a limited background in the education field?

4.2.2.3 Contextual issues

At a contextual level I am irate about the short duration of the N4 qualification and the volume and depth of content I am expected to cover in 3 months. Further the students that are accepted to pursue the N4 QS qualification often lack a technical background and they have a minimum pass of 30% in mathematics and physical sciences which exacerbates the learning difficulties they encounter and challenges my teaching. I am overwhelmed by the contextual challenges and I'm still trying to rationalise how to address them.

4.3 Part B: Research Question Two

In this section I present the data generated via interviews and my reflections in order to answer Research Question Two (Why N4 QS students engage with the assessing and processing of

information from engineering graphics and specification drawings the way they do). Content analysis of the individual interviews conducted revealed the rationale for N4 QS students' engagement with assessing and processing information from engineering and graphics and specification drawings the way they do. The following eight aspects emerged as their rationale for assessing and processing information from engineering graphics and specification drawings the way they do:

- Student background;
- Perception of learning environment;
- Teaching style;
- Study habits;
- Carelessness;
- Low literacy level to read diagrams;
- Low numeracy skills to perform simple calculations; and
- Lack of awareness of the standard system.

4.3.1 Student background

All five students who consented to participate in the study come from disadvantaged backgrounds and they attended previously disadvantaged schools. Four of the five participants (S2-S5) pursued mathematical literacy at school level and their marks in mathematical literacy ranged from 40% to 50%. Only S1 pursued mathematics in school with a mark of 55%. The excerpts below provide an insight into the student backgrounds.

> S1: "*At home I don't have a place to study, I wait for everyone to sleep, then its quiet and I try to go over my work. It's hard.., sometimes I work to get money to buy food – there is never enough food…"*

> S3: *"I live with my gran, she is old and sickly, I take care of my siblings, four of us, it not easy to do that and have time to study. I stay away when I don't have bus fare or when my gran is sick. I have no parents.*"

The above excerpts elucidate the dilemmas students encounter in their daily life (*I don'thave a place to study I work to get money to buy food;.. to do that and have time to study … stay away when I don't have bus fare*)that hinder and impinge on the opportunities for engagement and learning at DCC. These dilemmas raise questions such as how can students remain committed and motivated to study when they are hungry, serve as care givers, have no money? How can I support the N4 QS students via my teaching?

4.3.2 Perception of learning environment

Students' perception of their learning environment focused on their home environment and the environment at DCC as reflected in the excerpts below.

> S2: "*I can't study at home, there no place to study, I try to study on campus but it's not always possible – asstudents are so noisy and the campus is in the middle of town – there are so many distractions.*"

> S4: "The *picture in the advert of this campus does not match the facilities available to us."*

> S5*: "There are no books that I can find in our library that can help me cover or learn what I need to know about reading engineering graphics and specification drawings."*

The above excerpts create a bleak picture of students learning environments both at home and on campus. These perceptions beg the question: How can learning and engagement occur in an environment that that does not allow for it?

4.3.3 Teaching style

Students perceptions on my teaching style was very revealing as can be seen in the excerpts below.

> S1: *"I understand some of the things that are taught when I can hear them, but the teacher is too soft spoken, he needs to be loud so he can be heard – his voice compete with all the other noises"*

S4: *"I find it hard to understand what is being said during the lesson – we all speak differently."*

S3: "*It's not like the teacher does not know his work he just needs to teach differently."*

The above excepts illuminate the flaws in my teaching that I need to change in order to maintain the interest and promote learner engagement in my module.

4.3.4 Study habits

The study habits of the students are visible from the excerpts below.

S3: *"I don't know how to study, no one showed me how to, in my school we just swotted the information without understanding it – I wrote what I learnt and passed, I'm still doing this and now I'm failing."*

S5: "*I only read my work before a test – there is no time to study – I try and remember a diagram and identify the dimension – it hard to learn so much and the diagram in the test/exam is always different, then I fail?"*

The lack of knowledge on how to study comes to the fore via the above excerpts. Not knowing how to study differently from previously relied upon study habits is a huge problem for the students and it impacts their engagement with engineering graphics and specification drawings, which requires the ability to read, interpret and apply information. The excerpts above indicate that students do not spend much time studying as their time is spent performing chores such as caring for siblings, working part time, travelling.

4.3.5 Carelessness

The excerpts below bring to the fore the carelessness of students when they engage with assessing and processing information from engineering and graphics and specification drawings.

S2: *"I was careless, I don't see the need… they can be written in any order, the task was long."*

S5: *"I transferred the wrong data onto the abstract sheet… aay .. Everything was wrong cos of this... time is a problem."*

The carelessness of the students could be attributed to their study habits (*I don't see the need*). Not having a logical or sequential way to (re)present facts/figures impacts how information is processed (*they can be written in any order*) and thereby contributes to the students carelessness. Further, it was noted that time constrains (*time is a problem, the task was long*) encountered during the task based activity resulted in carelessness on the part of students (*don't see the need, transferred the wrong data*). This carelessness cost them dearly as it impacts on the quality of their work and their response to subsequent linked questions (*everything was wrong cos of this*). In acovertway the link between carelessness and time constraints reveals the lack of sufficient thinking time to read and interpret what is required and expected for a question.

4.3.6 Low literacy level

The N4 QS students in this study encountered difficulty with reading/interpreting engineering specification drawings as is reflected in the excerpts below.

S5: *"I took breadth as height and height as breadth, which was the mistake, I had problems reading the diagram."*

S3: "*I didn't attempt any of those follow up questions because I couldn't figure out the measurement on the drawings, I find this work challenging."*

The above excerpts exemplify that the students needed prerequisite learning on how to read diagrams (*I had problems reading the diagram, I couldn't figure out the measurement on the drawings*) before they could be able to abstract or extrapolate information from the diagram to engage in related activities (*I didn't attempt any of those follow up questions*). Due to their inability to read and interpret diagrams, N4 QS students in this study should be exposed to more hands-on

activities related to engineering specification drawing. This in a way will assist them to read, acquaint them with the rules of measurement and to manipulate information in learning and problem solving (Clements & Battista, 1992; Olkun, 2003). Their inability to read and identify simple concepts like breadth and length impinges on their ability to perform simple calculations.

4.3.7 Low numeracy skills to perform simple calculations

Many students encountered problems in performing simple calculations as is evident from the excerpts below.

S1*: "I could not figure out the breadth = 525 – 75 = 450."*

S4*: "Myuse of 0.14 for the center was a mistake, but I was not sure."*

S5: "*I simply added the dimensions instead of multiplying them."*

The above excerpts clarify that these students battle to process information even at a shallow level. As was evident in the excerpts above (see Section 4.3.2) students were unable to read and identify measurements on construction drawings for example they could not differentiate between length and breadth (*I could not figure out the breadth*)hence their calculations were incorrect. Pickens and Jagger (2005) described measurement and quantification as a process concerned with converting construction drawings into words and numbers in accordance with a strict set of rules. The implication is that these students are oblivious of these rules hence they cannot process information at a deeper level in order to be able to differentiate between length and breadth and thereby perform simple calculations from the construction drawing/s supplied. Studies have shown deeper approaches to learning are related to higher quality learning outcomes (Ramsden, 1992; Prosser & Millar, 1989; Trigwell & Prosser, 1991). Researchers such as Craik and Lockhart (1972) and Craik and Tulving (1975) have shown that information processed to a 'deep' level will be better remembered than information processed only to a 'shallow' or rote level. Further it is evident that the N4 QS students in this study do not link information to order to get a holistic view on how to read, interpret and perform simple calculations based on the construction drawing that was provided in the task based activity.

4.3.8 Lack of awareness of standard system

Quantity Surveying lecturers should present to the learner the duties and function of the quantity surveyor (taking measurement from drawings, preparing bill of quantities, preparing tender documents, managing cost control on behalf of the employer), before attempting to explain in detail how to draw checklists for the substructure foundation, the superstructure floors, walls, doors and windows and roofing; and measuring from the checklists of the entire structure.

4.3.9 My reflections

The interviews that I conducted with N4 QS students had a profound effect on me Rather than reflecting on their engagement with engineering specification drawings I began introspecting on myself, my teaching and who the students I lecture to are. I declare upfront that I deviated from my data generation plan.

I really don't know the N4 QS students that I lecture even though I have a small class. Who are they? How can they not pass? What do they do at home? Do they even bother to study? Do they consider the effort I put into my teaching? Why are they absent so frequently? Why do they not seek clarity if they don't understand? What can be done to improve their low literacy and numeracy levels? These are a few of the questions that confronted me during Phase 2 of data generation. Am I unable to answer these questions because I don't care or is it because I am always trying to cram as much content as possible in a short space of time (two months)? What can I do to alter the prevailing situation?

Should I get the students to keep a learning diary so they can review their own learning process, the concepts they learnt, the ones they don't grasp as well as their transition to DCC and its environment? I think these students may be experiencing anxiety related to transition – when they moved from school to DCC and when they move between their 'home world' and the world of DCC. They are still adjusting to DCC and there seems to be a lack of connectedness to ease their move between these worlds which are so different. I was unaware of their roles in their home world. I think getting students to keep a learning diary will help them with the process of setting goals and having an agenda to learn. Via this research project I am also learning. Previously I never reflected on students' engagement or my teaching. I have come to realise that student engagement

also involves an emotional and cognitive aspect as well. The emotional aspect relates to students' reactions to teachers, the school context, their connectedness with the school and peers. The cognitive aspect refers to students' level of effort, their study habits, and their willingness to try new learning strategies.

I thought that when I spoke softly I was showing respect to the student and that I was not shouting at them. I didn't think that the audibility of my voice impacted their learning and engagement with content matter. I should also try and create a more collaborative learning environment in my class and adopt teaching approaches that suit my students' needs. I should encourage them to ask questions and I should also ask them questions while I teach. In retrospect I realise that I rely heavily on teacher centered methods of teaching without much room for student engagement. Further, I am more concerned with syllabus coverage and maximizing the delivery of information (such as rules, definitions, procedures for students to memorise) rather than student learning; as a result, I pay little attention to students' needs or misconceptions. I can see the link between my teaching and why N4 QS students engage with the assessing and processing information from engineering and graphics and specification drawings the way they do. Figure 3 is a synthesis of my reflections.

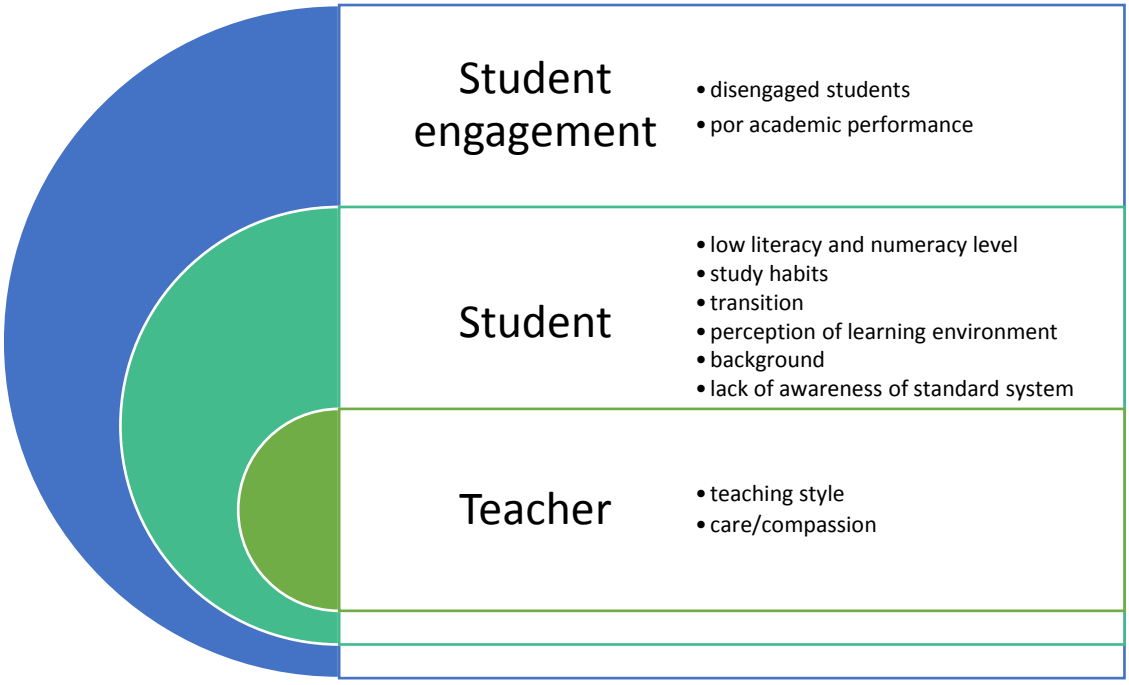


Figure 3: Engaging with engineering graphics and specification drawings

4.4 Part C: Research Question Three

In part C, I present the data generated via collages, concepts maps, and my reflections in order to answer research question three namely, "What factors promote or impede N4 QS students' engagement with the assessing and processing of information from engineering and graphics and specification drawings?"

4.4.1 Collages

As alluded to in the methodology chapter earlier the collage was composed by the five students as a group who participated in this study as reflected in Figure 4.

Figure 4: Collage: subject matters

A closer examination of the collage (Figure 4) unveils the hidden realities that the N4 QS students encounter at two levels, namely home life and "school" life. The home life level brings to the fore challenges students encounter daily as being part of a family such as "competition" for time (image labelled 1 – watch). Having to juggle family responsibilities (images labelled 3 and 4) with study responsibilities (image labelled 2). Time is an invaluable resource that students need to be able to manage in order to have more of to devote to their "school life". Additional dilemmas and challenges students encounter in their home lives are house hold chores such as taking care of siblings (image labelled 4); having to deal with anxieties (image labelled 6) about bills (Rand notes) (image labelled 5) as well as uncertainties about # fees. These anxieties coupled with the challenge for time signifies the common feeling students had of being overwhelmed and inadequate. They felt torn apart by the many demands being made on their time. These multiple anxieties permeate their school life and have a crippling impact on their academic performance.

At the "school life level" the collage reveals what N4 QS students consider as imperative to their learning experiences with regard to their engagement with engineering graphics and specification

drawing and academic progress. The image of a student standing with his hands on his hips against the chalk board that is full of writing (image labelled 7) depicts that students can overcome the challenges they encounter in their "school life" if they are provided with the "tools" to fit the pieces of the puzzle together (picture labelled 8). The image of the pieces of the puzzle (image labelled 8) together with the words "having the tools" signify that students want to overcome the challenges they encounter (see Section 4.3 for discussion on the challenges) during their engagement with engineering graphics and specification drawings. N4 QS students have via their collage explicitly requested for themselves to be construed as "rare investments" (image labelled 9) and have linked the notion of them being "rare investments" to "subject matters" and "teachers to go the extra mile" (also labeled as image 9). It is evident that N4 QS students were searching for ways to improve their engagement with engineering graphics and specification drawings by asking the "teacher to go the extra mile". These students are turning to teachers to demystify the jargon and confusion they encounter (image labelled 8) in their engagement with engineering graphics and specification drawings. N4 QS students invariably noted that their academic success hinges on the teacher as well as the teaching methods used in order for them to be "reinvented, remodeled and reborn" in terms of engineering graphics and specification drawing.

4.4.2 Concept maps

After the creation of the collages the group transcribed the meanings made from the collage into a concept map (Figure 5). The concept map assisted in "compiling an inventory of denotations for the collage by listing the constituent elements systematically and cataloguing the literal meanings of the images and pictures posted on the collage" (Van Schalkwyk, 2010, p. 683). The main images from the collage were numbered consecutively in the concept map and sets of related concepts were grouped together to represent an understanding of relationships between important sets of concepts.

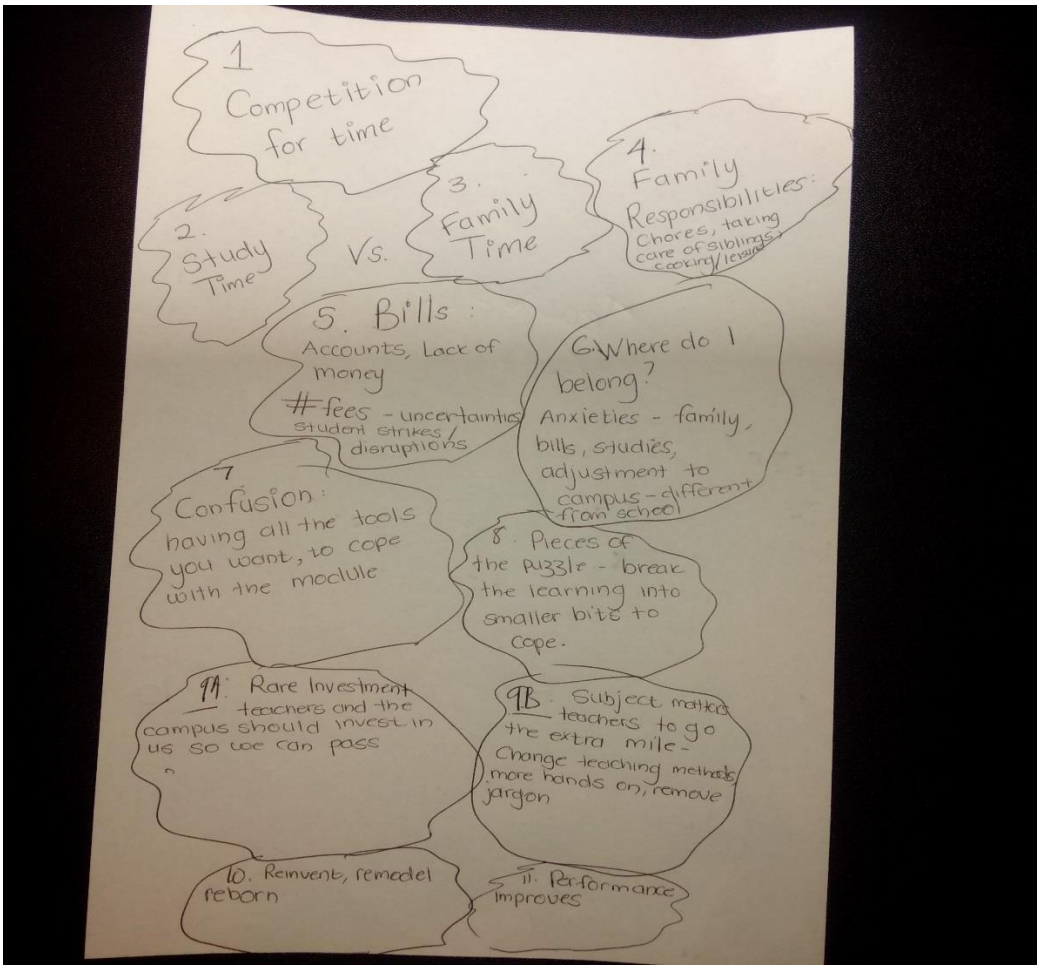


Figure 5: Concept map

The concepts were examined to see if they could be linked (see Figure 6 for linking of concepts). Concepts were linked into four overall themes that we identified, namely competition for time; anxieties feeling overwhelmed, tools of the trade and rare investment. These four themes are now explored further.

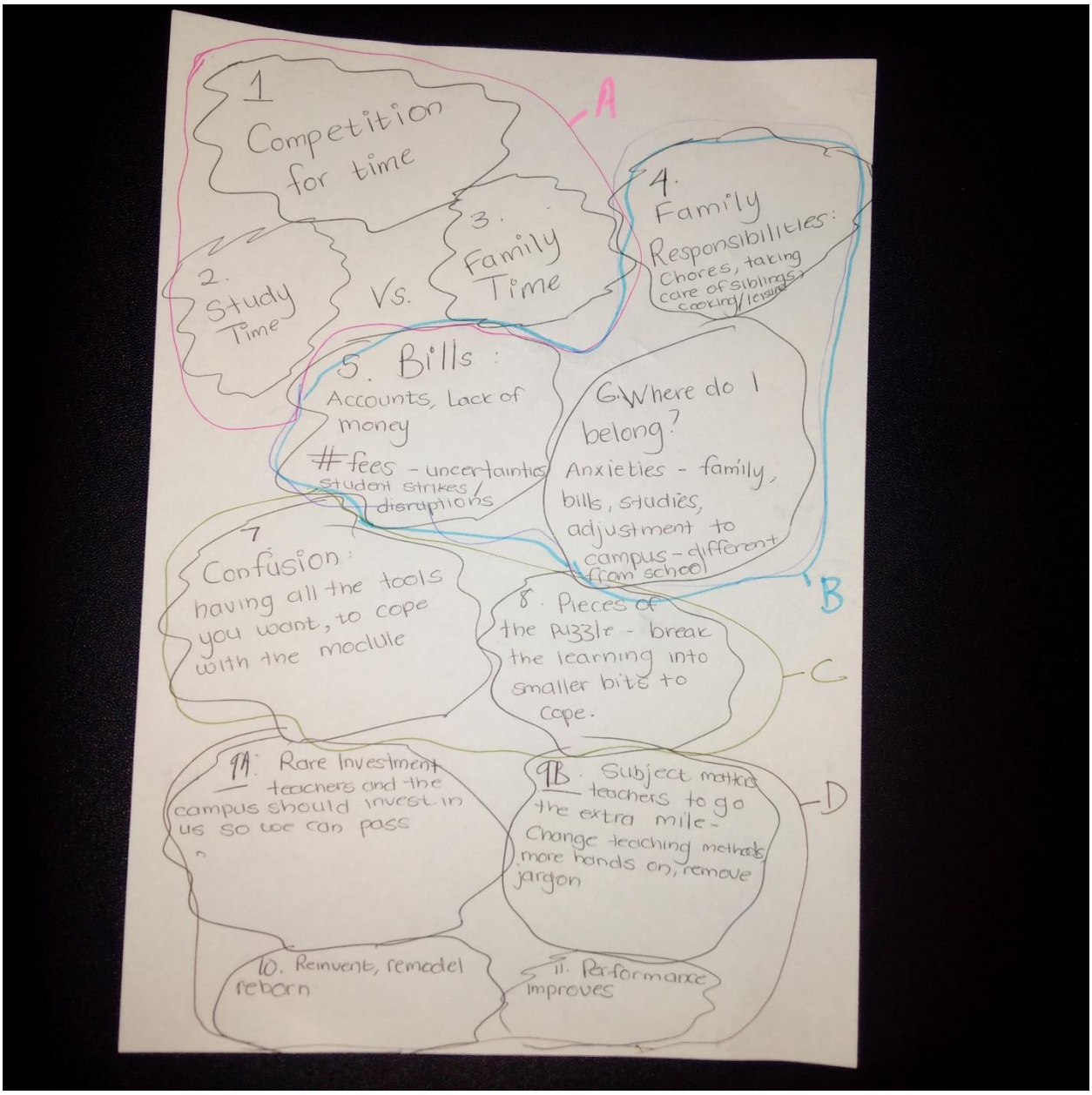


Figure 6: Concept map themes

4.4.2.1 Competition for time

This theme was strongly highlighted in the collage and it brought to the fore the constant juggling of time that students encounter. In this grouping (see label A on concept map in Figure 6) the tension between study time and family times was made explicit and resulted in anxieties.

4.4.2.2 Anxiety and feeling overwhelmed

The juggling between family life and study time was exemplified by the many hats that students wore (*where do I belong*) as well as the roles or duties they play/undertake in their day to day life, such as chores, taking care of siblings, heading households, socializing with family, and leisure time with family. These contesting issues vied for students' attention and ate into their time available for studying. Often these role/duties were conflicting and resulted in anxieties, uncertainties and feeling of being overwhelmed. A brief glimpse of the financial challenges students encounter become visible (*bills, lack of money*). Furthermore, the uncertainties students experience in their transition from school to college becomes conspicuous (*# fees, student strikes, adjustment to campus life, different from school).* Thefeeling of vulnerability that stems from not knowing about fees or rather how their fees will be paid as well as student strikes is a reality the students have to deal with. With strikes there is a loss of teaching time and this impacts on their learning. The aforementioned issues place the students under strain and leaves them feeling lost and isolated. These uncertainties multiply their anxieties. Therefore, it is necessary for students to find a balance between the various roles they plays, and students must be adept at attending to a variety of factors and assessing priorities.

4.4.2.3 Tools of the trade

The sense of vulnerability and uncertainty that students encounter during their transition to college life coupled with their juggling for time is overwhelming therefore their failure at being able to cope with the core content of the N4 QS qualification, such as being able to read and interpret engineering graphics and specification drawings seems inevitable. Students have inserted their needs into this collage. This need is visible (see part labelled C in the concept map in Figure 5) and there is a suggestion that the N4 QS content should be broken down into "smaller bits, like the pieces of a puzzle" so that it can be accessible to them (*cope with the module*) and they can be equipped to deal with the content (*having all the tools you want*). This request can be traced back to the outcome of their task based activity, namely their inability to read diagrams, their lack of skills to perform simple calculations and their lack of awareness of the standard system (see Section 4.3. for more details).

4.4.2.4 Rare investments

The National Development Plan (Republic of South Africa, 2012) has noted that South Africa's development is being hampered by a serious shortage of skilled engineers, quantity surveyors, construction managers and construction project managers (see Section 1.1). Furthermore, the job of the quantity surveyor is a crucial one as it is his or her task to manage the value-for-money and cost of building projects (Azodo, 1993). Therefore, the cognitive development of students pursuing the aforementioned courses at Higher Education Institutions needs to be given added attention (*so we can pass*) as they are indeed rare investments in our country's future development. This investment could be a turning point that is needed to address the skills shortages mentioned earlier. The students in this study realise the challenges they encounter with engineering graphics and specification drawing in the QS course and make an appeal for help in order to succeed with their studies at DCC (*teachers and the campus should invest in us*). In a way students are displaying agency, they see themselves as a component together with teachers as solutions to their development. Therefore, a special appeal is directed towards the QS teachers (*subject matters, go the extra mile, change teaching methods, remodel*) in order to reduce students' feelings of isolation from content (*remove jargon, more hands on*) as well as increase their confidence and cognitive growth. This investment in the students will help them to be *reinvented, reborn and thereby their performance will improve*. Establishing a conducive learning environment to facilitate student transition from school to college is critical for student engagement and success. The following trends were identified: cultivating hope, support, changing teaching methods.

4.4.3 My reflections

Having reflected on Phase 3 of data generation, especially having observed the students engaging in collage making and concept mapping, I realise that the factors that impede N4 QS students' engagement with engineering graphics specification drawings are: student background, perception of learning environment, teaching style, study habits, carelessness, inability to read diagrams, lack of skills to perform simple calculations, lack of awareness of the standard system, students inability to juggle family responsibilities with study responsibilities, anxieties, confusion, being overwhelmed by large volumes of content information (jargon). The factors that can promote N4 QS student engagement with the assessing and processing information from engineering and

graphics and specification drawings are equipping students with the skills needed to cope with the module content, breaking the content into smaller bits that are more comprehensible, changing my teaching methods, having more hands-on activities, having a positive expectation of students as well as getting to know them.

Engaging in this research project has made me realise that teaching goes beyond the delivery of content to comply with syllabus requirement. There are specific teaching 'behaviours' which when implemented appropriately in my classroom will impact student engagement and thereby improve students' academic achievement. Teaching goes beyond the technical aspects of maintaining a register, recording marks and completing the syllabus. A large part entails having your heart in it as well, it has a moral and ethical dimension as well. I have an obligation to my students. I now am thinking about how to use the knowledge I acquired about factors that impede and promote N4 QS N4 QS students' engagement with the assessing and processing information from engineering graphics and specification drawings in the planning of my teaching (both in terms of the subject matter content and the teaching strategies that I use). How I portray important content specific information to students is now important to me. I must be able to convey these complex ideas in a simpler way that is accessible to students. I must be more sensitive to the challenges students encounter during their engagement in order to improve my teaching.

Having undertaken this study I realise that for students to engage with engineering graphics and specification drawings there needs to be synergy between the students and my teaching and that I need to be aware of the contextual factors that impinge their engagement as synthesised in Figure 7.

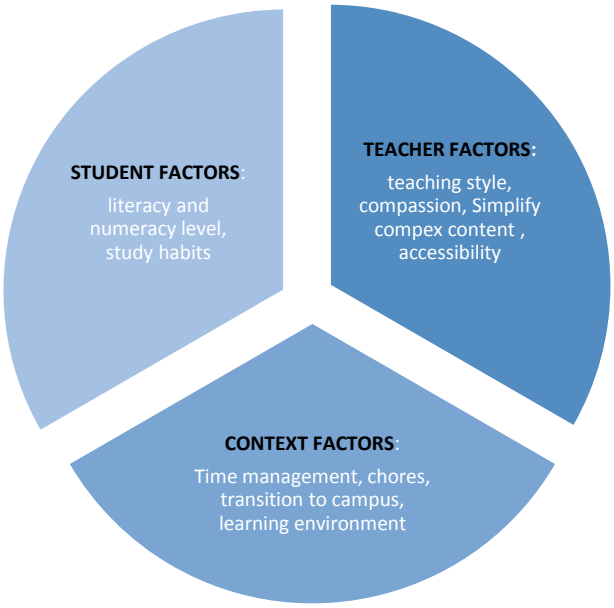


Figure 7: Synergy between student factors, teacher factors and contextual factors

It is the contextual factor that undergirds the possibilities for student engagement.

4.5 Conclusion

In this chapter I set out to answer the three research questions posed by this study.

To answer the first research question (How do N4 QS students' engage with the assessing and processing of information from engineering and graphics and specification drawings?) I engaged in content analysis of the task based activity. The activity was marked according to the memorandum (see Appendix A5 for memorandum). The analysis highlights that only S1 had more than 50% in the task based activity and that four students (S2-S5) did not pass the task based activity and are encountering problems with reading and interpreting engineering graphics and specification drawings and the subsequent preparation of the BQ. It is evident that participants S1-S5 of this study were not fully immersed in their engagement with engineering graphics and specification drawing during their lectures, simulations and tutorials. Hence they were unable to progress to the RO stage, which comes into play when the learner consciously reflects and draws conclusions on their gained experience through thought questions, brainstorming, discussion and personal journals (Bergsteiner & Avery, 2014). The progression from one stage to the next in

Kolb's ELT model demands a tentative, impartial perspective of the learning situation, which the N4 QS students seem to lack. My reflections on students' performance on the task based activity reveal that I still depend on teacher centred teaching.

Data from the individual interviews conducted with N4 QS students was used to answer the second research question (Why do N4 QS students engage with the assessing and processing of information from engineering graphics and specification drawings the way they do?). Content analysis of the individual interviews conducted revealed the rationale for participants' engagement with assessing and processing information from engineering and graphics and specification drawings the way they do to be carelessness, inability to read diagrams,lack of skills to perform simple calculations and lack of awareness of the standard system. My reflection on the first and second phase of data generation reveal the moral and ethical dimensions of being a teacher. Teaching is not just a technical skill.

To answer the third research question (What factors promote or impede N4 QS students' engagement with the assessing and processing of information from engineering and graphics and specification drawings?) data was generated via a collage and a concept map. The collage unveils the hidden realities that the N4 QS students encounter at two levels, namely home life and "school" life level. The home life level brings to the fore challenges students encounter daily as being part of a family such as "competition" for time, having to juggle family responsibilities with study responsibilities. Time is an important resource that students need to be able to manage in order to have more of to devote to their "school life". Four overall themes via the concept map, namely, competition for time, anxieties feeling overwhelmed, tools of the trade, and rare investment. Upon exploring these themes further the factors that impede or promote N4 QS students' engagement with the assessing and processing information from engineering and graphics and specification drawings were identified during my reflections. The factors that impede N4 QS students' engagement with engineering graphics specification drawings are: carelessness, inability to read diagrams, lack of skills to perform simple calculations, lack of awareness of the standard system, students' inability to juggle family responsibilities with study responsibilities, anxieties, confusion, being overwhelmed by large volumes of content information (jargon). The factors that can promote N4 QS students' engagement with the assessing and processing information from engineering and graphics and specification drawings are equipping students with the skills needed

to cope with the module content, breaking the content into smaller bits that is more comprehensible, changing my teaching methods, having more hands-on activities, having a positive expectation of students as well as getting to know them. The finding of this study has challenged me to reflect on the moral and ethical aspects of teaching and not just the technical aspects of teaching. In the last chapter, I discuss the implications of the findings of this study for teachers of QS.

CHAPTER 5 : CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of this study, as mentioned earlier in Chapter 1, was to explore how N4 QS students engage with the assessing and processing of information from engineering graphics and specification drawings, to ascertain why N4 QS students engage with the assessing and processing of information from engineering graphics and specification drawings the way they do and to identify the factors that promote and impede N4 QS students' engagement with the assessing and processing of information from engineering graphics and specification drawings. Data was generated in three phases using a task based activity, individual interviews, collage, concept map and self-reflections. Data collated was exposed to content and thematic analyses. The analysis of the data generated to answer Research Question 1 illuminated that for question two of the task based activity all participants scored zero on this question. Research Question 2 was designed to test N4 QS students understanding of practical construction procedures. It is clear that the participants (S1-S5) of this study were unable to progress to the RO stage of Kolb's ELT, which comes into play when the learner consciously reflects and draws conclusions on their gained experience through thought questions, brainstorming, discussion and personal journals (Bergsteiner & Avery, 2014). Judging by the responses of all 5 participants (S1-S5) to the task based activity it can be inferred that they all lack competencies – such as being able to communicate effectively, be innovative with problem solving ability, use the theories generated to make decisions and solve problems leading to new experiences, and are static in the CE stage.

Data analysis for Research Question 2 unveils the N4 QS students' rationale for assessing and processing information from engineering and graphics and specification drawings the way they do, namely: carelessness, inability to read diagrams, lack of skills to perform simple calculations and lack of awareness of the standard system. Data analysis to answer Research Question 3 reveals the factors that impede or promote N4 QS students' engagement with the assessing and processing information pertaining to engineering graphics and specification drawings. Student engagement

was seen as a way to re-engage or reinvent N4 QS students in engineering graphic specification drawing in order to improve their academic engagement and performance.

In this chapter I reflect on the implications of this study. I also outline recommendations that are based on the findings for appropriate QS student engagement, my development as a reflexive teacher and suggestions for further research are presented.

5.2 Implications of this study

5.2.1 Reflective practice and its impact on me

This research project has had a profound influence on my practice and has altered the way I now think about my role as a teacher. In this section I ponder on the intricate, intertwined relationship between my practice, reflection and student engagement. The finding of this study made me realise that even though a teacher may possess a substantial amount of subject-matter knowledge, he/she may be unable to design and implement instructional methods to enhance student learning due to a lack of pedagogical ability. The findings of this study points to the intersection between what teachers do in their classroom with student engagement as can be seen in Figure 8.

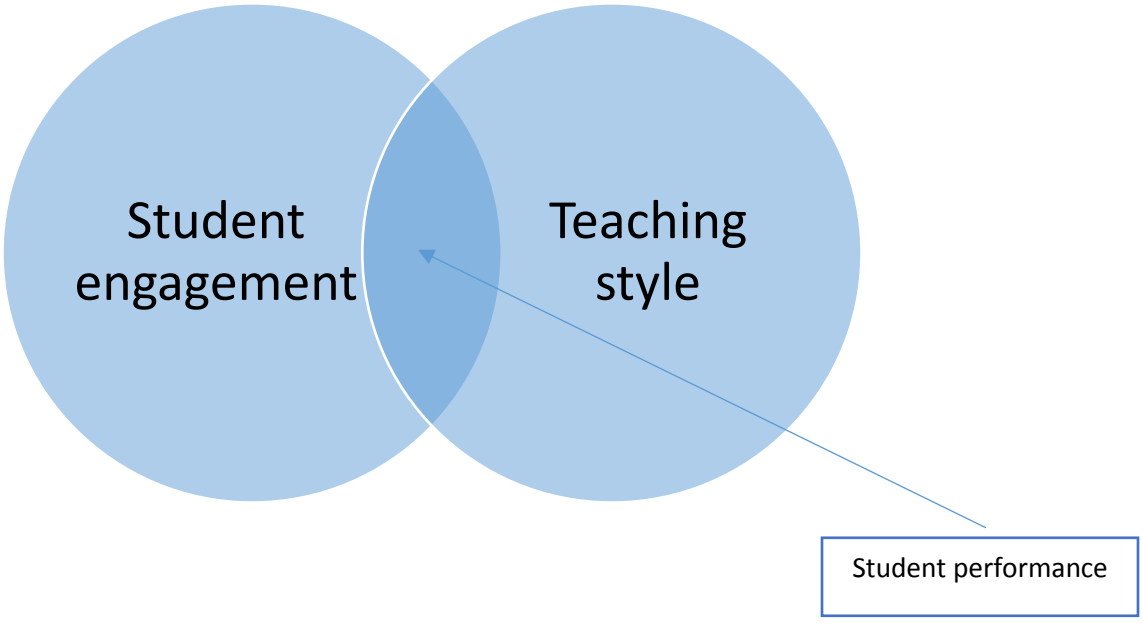


Figure 8: Intersection between student engagement and teaching style

When teachers use effective practices (teaching styles), they maximise the probability that students will be actively engaged in instruction and learning. At the intersection of teaching style and student engagement lies student performance/achievement. This means that student engagement serves as a predictor of achievement; and that when students are more engaged in academic instruction, they tend to have greater academic success. Therefore, improving student learning and achievement by developing instruction to meet the needs of all students is crucial to my teaching. I now (after this study) construe teacher reflection or reflective practice as a vehicle to bring about change in student engagement. Reflection entails a culture of thinking about teaching, making judgements and decisions that can necessitate thoughtful deliberations on purposeful actions in order to improve learner understanding, engagement and their academic performance (Schon, 1987).

Reflection has provided a context for me to use my decision-making skills to analyse the learning environment, assess learner knowledge gaps and think of how to reduce them, improve questioning techniques, and evaluate the pace of a lesson and the suitability of activities to enhance students' understanding and engagement. By engaging in effective decision-making during teaching I am now able to question the relevance of the content the students are learning, level of challenge, and decisions on viable ways of presenting the same content so that all the different ability levels of students in a class can be challenged to think deeply. I have noted that reflection involves looking at a teaching episode as it unfolds and assessing the level to which it is effective in terms of student understanding. The insight derived from post-lesson reflections makes it possible to evaluate the effectiveness or ineffectiveness of my strategies of instruction, decisions taken, or activities organised for a lesson. Such insight now provides me with pedagogical choices in ways that provide me with an understanding of my teaching practice as well as a commitment to my personal and professional growth as a teacher.

By engaging in reflective practice I am able to modify, refine and replicate the best practice whilst simultaneously avoiding inferior practice. In this way my practice is reborn, remodeled and reinvented as I now know not only what to do but more importantly why is must be done. As a result of this research project I have developed a positive disposition towards reflection.

5.2.2 Reflective practice and professional development at DCC

At DCC there isn't much room for professional development, neither are we equipped to deal with the multiple challenges our students encounter. Having only just began to embark on reflective practice, I am of the opinion that if a collegial space is created or provided at DCC, we (the staff) can collaboratively develop habits of mind to engage in reflective practice or invite individuals who can guide us in this process. Sometimes a lot of money is not required to initiate professional development; rather an inside-out strategy could be used. For example teachers who demonstrate expertise in posing and solving teaching and learning problems are good mentors to bring about change in practice. They usually have the ability to listen analytically, focusing on key information that helps clarify what needs to be explored, and they have expanded repertoires of options.

In such a collegial space mentors could pose questions that lead their colleagues to ask productive questions themselves, to consider other sources of information that might provide additional insight, and to generate their own possible solutions. Discussions and role-plays can help teachers to ask themselves questions about their classroom practice such as: What worked in this lesson, how do I know? What would I do the same or differently if I could teach the lesson again? What do I believe about how students learn? Is this the most effect way to engage students? If colleagues collaborate in drafting a plan for implementing change and formally schedule follow-up discussions, this will encourage the less experienced teacher to self-monitor and reflect further.

A deep understanding of the content and how to teach it is crucial to enhance the teachers' classroom practice or pedagogy. Essential improvements to the quality of teaching and learning are more likely if teachers make a concerted effort to reflect on their practice (Kane, Sandretto, & Heath, 2002).

5.3 Recommendations

Arising from the findings of this study, the following recommendations to improve students' engagement – not just with engineering graphics specification drawings but in all modules – are proposed. The following factors need to be re-examined at DCC: student teacher interaction, managing disengaged students and modelling engaging teachers.

5.3.1 Student teacher interaction

High levels of student wellbeing are important for a student to be able to identify with their learning environment. Hattie (2003) noted that strong classroom management and student-teacher relationships have a significant impact on engagement and achievement. In other words, students need a safe environment, one that is not just physically safe, but is also a place where students feel able to make mistakes and ask question that may be regarded as silly without being mocked or laughed at. When students are cautious about contributing to a lesson or are afraid to be corrected in the presence of their classmates then it is difficult to motivate them to learn. Motivation is a fundamental part of engagement. Mutual respect is needed to foster high learning expectations whereby a student is able to shape his/her own goals. Therefore effective, hands-on, engaging teaching is needed. Teachers of DCC have little or no teaching qualifications – many are professional qualified engineers, quantity surveys etc.

5.3.2 Modelling engaging teacher

Practicing teachers need support for engaging with practice, to ensure they are implementing approaches that will work for their students. As mentioned above, many teachers at DCC do not have a teaching qualification which means their training experience is highly theoretical and they need support to translate their theory into practice and how to engage students.

This means that at DCC, engaging teaching needs to be modelled for teachers to learn effective teaching. Instructional leadership, observation and discussion of colleagues' effective practices enables teachers to access and learn from examples of effective practice. Being observed also provides teachers with alternative viewpoints about what was successful in their classroom. Professional collaboration, such as through learning groups, enables teachers to share ideas about what works with students at different levels of engagement. Not only can teachers learn new things from these groups, but it challenges them to confront their own practice – to adapt and evaluate for continuous improvement. Feedback and appraisal helps teachers to determine if their classroom performance is having an impact on the engagement of their students.

5.3.3 Managing disengaged students

Within all classrooms, there is scope for teachers to make learning feel more relevant to students. Many disengaged students feel that school is not relevant to them. Professional collaboration, observation of practice, feedback and appraisal can be important ways for teachers to learn from one another about how to engage students. According to Seal (2009), monitoring student engagement together with identification of disengaged students is the vital first step in ensuring that help is targeted towards these students to re-engage them in the learning process. Teaching can be observed to help identify students demonstrating engaged, and disengaged learning behaviours. Monitoring is an important part of the process for teachers.

5.4 Recommendations for further research

Further research should be conducted to ascertain the existence and effectiveness of continuous professional development at DCC. The frequency and effectiveness of such workshops should also be researched, in order to identify ways of making them more effective for the benefit of teachers and to promote student engagement in all fields of study at DCC. There should be partnership between DCC and teacher training institutions to jointly develop or initiate continuous professional development for teacher who lack a teacher training qualification.

5.5 Conclusion

The findings of this study clarify that student engagement hinges on the learning environment, the student's learning style and the teachers' teaching style. The finding bring to the fore the following tensions, namely the tension between the lengthy N4 QS curriculum and the short duration(3 months) of the course as well as thecognitive demands made on students wholack the basic mathematical skills and background knowledge needed to engage with the N4 QS content.

REFERENCES

Astin, A. W., Banta, T. W., Cross, K. P., El-Khawas, E., Ewell, P. T., Hutchings, P., Marchese, T., McClenney, K., Mentkowski, M., Miller, M., & Moran, E. (1992). Nine principles of good practice for assessing student learning. *AAHE Bulletin, 45*(4).pp 12-13

Amerson, R. (2011). Making a case for case study research. *Journal of Nursing Education*,*50*(8), 427-428.

Armstrong, E., & Parsa-Parsi, R. (2005). How can physicians' learning styles drive educational planning? *Academic Medicine, 80*(7), 680-684.

Ashworth, A., & Hogg, K. (2007). *Willis's practice and procedure for the quantity surveyor.* (12th ed.). Oxford: Blackwell.

Australian Institute of Quantity Surveyors. (n.d.) About. Retrieved from http://www.aiqs.com.au/imis/AIQS_Website/About/What_is_a_QS_/AIQS_Website/About/What_is_a_QS_.aspx?hkey=75ff0452-67ec-4747-8100-34fb97d1e989.

Azodo, A. U.9(1993). *L'imaginaire dans les romans de Camara Laye.* New York: Peter Lang.

Bergman, L. G., & Fors, U. G. (2005). Computer-aided DSM-IV-diagnostics: acceptance, use and perceived usefulness in relation to users' learning styles. *BMC Medical Informatics and Decision Making, 5*, 1.

Bergsteiner, H., & Avery, G. C. (2014). The twin-cycle experiential learning model: reconceptualising Kolb's theory. *Studies in Continuing Education, 36*(3), 257-254.

Bertram, C. (2003). Students doing it for themselves: the role of informal study groups in a mixed mode teacher education programme. *South African Journal for Higher Education, 17*(3), 218-225.

Biggs, J. (2003). Aligning teaching for constructing learning. *Higher Education Academy*,volume 1-4.

Bligh, D. A. (2000). *What's the use of lectures*? San Francisco: Jossey-Bass.

Bowie, L. (1998). *A learning theory approach to students' misconceptions in calculus.* Unpublished Thesis, University of Cape Town, Cape Town.

Branoff, T. J., Hartman, N. W., & Wiebe, E. N. (2003). Constraint-based solid-modeling: what do the employers want our students to know? *The Engineering Design Graphics Journal, 67*(10), 6-11.

Brown, H. D. (2000). *Principles of language teaching and learning* (4th ed.). White Plains, NY: Longman.

Butler-Kisber, L., & Poldma, T. (2010). The power of visual approaches in qualitative inquiry: the use of collage making and concept mapping in experiential research. *Journal of Research Practice, 6*(2), 18.

Carlson, J. A. (2010). Avoiding traps in member checking: *The Qualitative Report,15*(5), 1102-1113.

Campbell-Jones, B., & Campbell-Jones, F. (2002). Educating African American children: Credibility at a crossroads. *Educational Horizons, 80*(3), 133-139.

Celce-Murcia, M. (2001). Language teaching approaches: An overview. In M. Celce-Murcia (Ed.), *Teaching English as a second or foreign language* (pp. 3-11). Boston: Heinle & Heinle.

Chan, V., Pisegna, J. M., Rosian, R. R. &DiCarlo, S. E. (1991). Construction of a model demonstrating neural pathways and reflex arcs. *Advances in Physiology Education, 271*(Part 3), S14-42.

Chan, C. K. Y. (2012). Identifying and understanding the graduate attributes learning outcomes in a case study of community service experiential learning project. *International Journal of Continuing Engineering Education & Life Long Learning, 22*(1), 148-159.

Clark, D., & Linn, M. C. (2003). Designing for knowledge integration: the impact of instructional time. *The Journal of the Learning Sciences, 12*(4), 451-493.

Clements, D. H., & Battista, M. T. (1992). Geometry and spatial reasoning. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning*. New York: Macmillan.

Cohen, L.,& Manion, L. (1980). *Research methods in education*. (4thed).London: Routledge.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education.* (5th ed.).London: Routledge.

Cohen, L., Manion, L. & Morrison, K. (2011). *Research methods in education.* (7th ed.). London: Routledge Falmer.

Cohen, L., Manion, L., & Morrison, K. (2013).*Research methods in education.* (8th ed.).London: Routledge.

Cottrell, S. (2008). *Teaching study skills and supporting learning*. Basingstoke: PalgraveMacmillan.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: a framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*(6), 671-684.

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, *104*(3), 268-294.

Creswell, J. W. (2012). *Research design: Qualitative, quantitative, and mixed methods approaches*. Los Angeles: Sage.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among the five approaches.* (4th ed.). Los Angeles: Sage.

Creswell, J. W. & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into Practice, 39*(3), 124-131.

Cuaresma, J. (2008). *Learning style preferences and academic performance of PHEM majors at the University of the Cordilleras.*(Unpublished thesis). University of the Cordilleras, Baguio City.

Davis, P. R., Love, P., & Baccarini, D. (2009). Bills of quantities: nemesis or nirvana? *Journal of Structural Survey, 27*(2), 99-108.

Denzin, N. K., & Lincoln Y. S. (2011). *Qualitative research.* (4th ed.). Los Angeles: Sage.

Denzin, N. K. & Lincoln, Y. S. (2005). Introduction: The discipline and practice of qualitative research. In N. K Denzin & Y. S. Lincoln (Eds.). *Handbook of qualitative research*. (3rd ed., pp. 1-32). Thousand Oaks, CA: Sage.

De Vos, A. S. (2002). *Research at grass roots* (2nd ed.). Pretoria: Van Schaik.

DiCarlo, S. E., & Collins, H. L. (2001). Colored letters: a tool to increase class participation in a large classroom. *Advances in Physiology Education, 25*(2), 70-71.

Dunn, R., & Dunn, K. (1978). *Teaching students through their individual learning styles. A practical approach.* Reston, VA: Prentice Hall.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 119-159). New York: Macmillan.

Etherington, K. (2004). *Becoming a reflexive researcher: Using ourselves in research*. London: Jessica Kingsley.

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education*, *78*(7), 674-681.

Flyvbjerg, B. (2006). Five misunderstandings about case study research. *Qualitative Inquiry, 12*(2), 219-245.

Fortune, C., & Skitmore, M. (1994). Quantification skills in the construction industry. *Construction Management and Economics, 12*(1), 79-88.

Gilakjani, A. P., & Ahmadi, S. M. (2012). The effect of visual, auditory, and kinesthetic learning styles on language teaching. In *International Conference on Social Science and Humanity,5*, 469-472.

Grushka, K., Hinde McLeod, J., & Reynolds, R. (2005), Reflecting upon reflection: Theory and practice in one Australian university teacher education program. *Reflective Practice,6*(2), 239-246.

Hattie, J. A. (2002). What is the nature of evidence that makes a difference to learning? Research conference proceedings (pp.11-21). Camberwell, VIC: Australian Council for Educational

Research. Retrieved from: http://research.acer.edu.au/cgi/viewcontent.cgi?article=1008&context=research_conference_2005.

Hesse-Biber, S., & Leavy, P. (2011). *The practice of qualitative research* (2nd ed.). Thousand Oaks, CA: Sage.

Hodgson, C., & Pyle, K. (2010). *A literature review of assessment for learning in science*. Slough, UK: National Foundation for Educational Research.

Hu, S., & Kuh, G. D. (2002). Being (dis)engaged in educationally purposeful activities: the influences of student and institutional characteristics. *Research in Higher Education, 43*(5), 555-575.

Huber, M. T., & Hutchings, P. (2004).*Integrative learning: Mapping the terrain. The academy in transition***.** Washington, DC.: Association of American Colleges and Universities.

Hughes, G. A. (1978). *The anatomy of quantity surveying*. Lancaster, England: The Construction Press Ltd.

Johnston, B. (2010). *The first year at university: Teaching students in transition*. Maidenhead, UK: Society for Research into Higher Education & Open University Press.

Johnson, R. B., & Christensen, L. (2008). *Educational research: Quantitative, qualitative and mixed approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Kabouridis, G. (2010). An innovation approach to face the first-year mechanical engineering students' conceptual difficulties in engineering design. Proceedings of 1st WIETE Annual Conference on Engineering and Technology Education. Melbourne: World Institute for Engineering and Technology Education.

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education, 38*(5), 758-773. doi: 10.1080/03075079.2011.598505.

Kane, R. G., Sandretto, S., & Heath, C. J. (2002). Telling half the story: a critical review on the teaching beliefs and practices of university academics. *Review of Educational Research, 72*(2), 177-228.

Khanare, F. (2009). We are not alone: taking an asset-based approach in responding to the needs of orphaned and vulnerable children. In C. Mitchell & K. Pithouse (Eds.), *Teaching and HIV & AIDS* (pp. 90-104). Johannesburg: MacMillan.

Kiliç, M., & Çakmak, M. (2013). Concept maps as a tool for meaningful learning and teaching in chemistry education. *International Journal on New Trends in Education and Their Implications, 4(*4), 14.

Knight, P. (2001). A briefing on key concepts: Formative and summative, criterion and norm-referenced assessment. *LTSN Higher Education Academy Generic Centre Assessment Series*. New York: Learning and Teaching Support Network.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Kolb, D. A. (1999a). *Learning style inventory, version 3.* Boston, MA: Hay Group.

Kolb, D. A. (1999b). *Learning style inventory, version 3: Technical specifications*. Boston, MA: Hay Group.

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2000). Experiential learning theory: previous research and new directions. In R. J. Sternberg & L-F. Zang (Eds.), *Perspectives on thinking, learning, and cognitive styles* (pp. 227-247). New York, Routledge.

Kolb, A., & Kolb, D. A. (2009). The learning way: Meta-cognitive aspects of experiential learning. *Simulation Gaming, 40*(3), 297-327. doi: 10.1177/1046878108325713.

Kovac, R. J. (1989). The validation of selected spatial ability tests via correlational assessment and analysis of user-processing strategy. *Educational Research Quarterly, 13*(2), 26-35.

Kuh, G. (2001). Assessing what really matters to student learning: inside the National Survey of Student Engagement.*Change, 33*(3), 10-17.

Kuh, G. D. (2003). What we're learning about student engagement from NSSE: benchmarks for effective educational practices. *Change, 35*(2), 24-32.

Kuh, G.D. (2007) How to help students achieve. *Chronicle of Higher Education,53*(41), 11-13.

Kuh, G. D., Kinzie, J., Schuh, J. H., & Whitt, E. J. (2005). *Assessing conditions for student success: An inventory to enhance educational effectiveness.*San Francisco: Jossey-Bass.

Kuh, G. D., Kinzie, J., Buckley, J., Bridges, B., & Hayek, J. C. (2007). Piecing together the student success puzzle: Research, propositions, and recommendations. *ASHE Higher Education Report*, 32(5). San Francisco: Jossey-Bass.

Kuipers, J.C.,& Clemens, D.L. (1998). Do I dare? Using role-play as a teaching strategy. *Journal of Psychosocial Nursing & Mental Health Services, 36*(7), 12-17.

Kumar, R. (2005). *Research methodology: A step-by-step guide for beginners.* (2nd ed.). London: Sage.

Kwakye, A. A. (1997). *Construction project administration in practice*. Harlow, UK: Addison Wesley Longman.

Laing, W. M. (1976). *A new approach to construction management through building measurement and time standards*. Lancaster: The Construction Press.

Lapan, S. D. (2012). *Qualitative research: An introduction to methods and design*. London: Jossey Bass.

Lasley, T. J. (1992). Promoting teacher reflection. *Journal of Staff Development, 13*(1), 24-29.

Lee, S., Trench, W., & Willis, A. (2005). *Willis's elements of quantity surveying* (10th ed.). Oxford: Wiley Blackwell.

Long, T.,& Johnson, M. (2000). Rigour, reliability and validity in qualitative research. *Clinical Effectiveness in Nursing,4*(1), 30-37.

Longhurst, R. (2010). Semi-structured interviews and focus groups. In N. J. Clifford & G. Valentine (Eds.), *Key methods in geography* (pp. 117-132). Thousand Oaks, CA: Sage.

Macfarlane, B. (2004). *Teaching with integrity: The ethics of higher education practice*. London: Routledge Falmer.

MacNaughton, G. (2003). *Shaping early childhood.* Maidenhead, UK: Open University Press.

Maree, D. J. F., & Maree, M. (2013). Multi-cultural differences in hope and goal-achievement. In M. P. Wissing (Ed.). *Well-being research in South Africa* (pp. 439-477). Dordrecht: Springer.

Marks, H. (2000). Student engagement in instructional activity: patterns in the elementary, middle, and high school years. *American Educational Research Journal, 37*(1), 153-184.

Mathews, M. (1998). *Constructivism andscience education*. Dordrecht, The Netherlands: Kluwer.

Mayaba, N.N. &Wood, L. (2015). The value of using folktales as an intervention to enhance resilience for children orphaned and rendered vulnerable by HIV and AIDS. *Education as Change, 19*(1): 10-35.

McMillan, J. H., & Schumacher, S. (2010). *Research in education: Evidence-based inquiry.* (7th ed.). Harlow, UK: Pearson.

McGlynn, A. P. (2008). Millennials in college: How do we motivate them? *Education Digest, 73*(6), 19-22.

Milliken, J. (1996). Bills of Quantities and the tendering process. *The Building Economist,* March, 5-7.

Nani, G., & Adjei-Kuni, T. (2007) The challenges of quantifying construction works for project control in Ghana. Paper presented at CIB World Building Congress, University of Science & Technology, Kumasi.

Newman, F. M. (1991). Linking restructuring to authentic student achievement. *Phi Delta Kappan, 72*(6), 458-463.

Norton, J. L. (1994). *The effects of time, teaching certification type, and field placement on reflective thinking in preservice teachers*. Paper presented at the Annual Meeting of the Association of Teacher Educators, Atlanta, GA.

Novak, J. D., & Cañas, A. J. (2008). *The theory underlying concept maps and how to construct them*. (Technical Report IHMC CmapTools 2006-01 Rev 01-2008). Florida Institute for Human and Machine Cognition.

Olkun, S. (2003). Making connections: improving spatial abilities with engineering drawing activities. *International Journal of Mathematics Teaching and Learning, 3*(1), 1-10.Retrieved from http://www.ex.ac.uk/cimt/ijmtl/ijabout.htm.

Ornstein, A. C., & Hunkins, F. P. (2009). *Curriculum foundations, principles and issues* (5th ed.). New York: Pearson.

Peck, A. C., Ali, R. S., Matchock, R. L., & Levine, M. E. (2006). Introductory psychology topics and student performance: where's the challenge? *Teaching of Psychology, 33*(3), 167-170.

Perez Carrion, T., & Serrano, M. (2012). Ejercicios para el desarrolo de la perceptionespecial. Editorial Club Universitario: Espania.

Pickens, D., & Jagger, D. (2005). Whither measurement. *RICS Journal, 12*(5), 45.

Prosser, J., & Loxley, A. 2008. Introducing visual methods. *NCRM Review Papers, 10.* Retrieved from http://eprints.ncrm.ac.uk/420/1/MethodsReviewPaperNCRM-010.pdf.

Prosser, J., & Millar, R. (1989). The how and what of learning physics.*European Journal of Psychology of Education, 4*(4), 513-528.

Quaye, S. J., & Harper, S. R. (Eds.). (2009). *Student engagement in higher education: theoretical perspectives and practical approaches for diverse populations.* New York: Routledge.

Raht, D., Smith, J., & MacEntee, K. (2009). Engaging youth in addressing HIV & AIDS: creative and participatory methods in the classroom. In C. Mitchell & K. Pithouse (Eds.), *Teaching and HIV & AIDS* (pp. 219-236). Johannesburg: MacMillan.

Radloff, A. (2011). *Report on the development of the University Experience Survey*. Melbourne: Universityof Melbourne Centre for the Study of Higher Education.

Ramsden, P. (1992). *Learning to teach in higher education*. London: Routledge.

Republic of South Africa. Department of Planning, Monitoring and Development. 2012. *National Development Plan 2010-2030.* Pretoria: Government Printer.

Rosebrough, T. R., & Leverett, R. G. (2011). *Transformational teaching in the information age: Making why and how we teach relevant to students.* Alexandria, VA: Association for Supervision and Curriculum Development.

Ross, D. D. (1989). First steps in developing a reflective approach. *Journal of Teacher Education, 40*(2), 22-30

Russell, G. M., & Kelly, N. H. (2002). Research as interacting dialogic processes: Implications for reflexivity. *Forum: Qualitative Social Research, 3*(3), Art. 18. Retrieved fromhttp://www.qualitative-research.net/index.php/fqs/article/view/831/1807.

Sammons, P. (2010). Do the benefits of preschool last? Identifying the impact of preschool on children's cognitive and social behavioural development at different ages. In K. Sylva, E. Melhuish, P. Sammons, I. Siraj-Blatchford & B. Taggart, (Eds.), *Early childhood matters. Evidence from the effective preschool and primary educaiton project*. London: Routledge.

Sammons, P., Smees, R., Taggart, B., Sylva, K., Melhuish, E. C., Siraj-Blatchford, I.,&Elliot, K. (2002).*The Early Years Transition and Special Educational Needs (EYTSEN) Project: Technical Paper 1 - Special Needs Across the Pre-School Period*. London: DfES / Institute of Education, University of London

Schon, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.

Seal, I. (2009). *Exploring the experiences of new teachers in working with students at risk of disengagement*. DOXA Youth Foundation, West Melbourne.

Seeley, I. H. (1997). *Quantity surveying practice*. London: Macmillan Press Ltd.

Sexwale, T. (2009). R1,3bn needed to fix badly-built RDP houses. Retrieved from http://www.polity.org.za/article/r13bn-needed-to-fix-badly-built-rdp-houses-sexwale-2009-11-16-1

Shulman, L. S. (1986). Those who understand: knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Shuttleworth, M. (2008). *Survey research design*. Retrieved from https://explorable.com/survey-research-design.

Silverman, D. (2010). *Interpreting qualitative data: methods for analyzing talk, text and interaction.* (3rd ed.). Thousand Oaks, CA: Sage.

Siraj-Blatchford, I., Sammons, P., Taggart, B., Sylva, K.,&Melhuish, E. (2006). Educational research and evidencebased policy: The mixed-method approach of the EPPE project. *Evaluation &Research in Education, 19*(2), 63-82.

Slavich, G., & Zimbardo, P. (2012). Basic principles of transformational teaching. *Educational Psychological Review, 24*(4), 569-608.

Sotsaka, D. S. (2015). *An exploration of grade 11 EGD teachers' understanding of assembly drawings: a case of Uthukela District.* (Unpublished master's thesis). University of KwaZulu-Natal, Durban.

Strydom, J. F. & Mentz, M. (2010a). *South African Survey of Student Engagement (SASSE): Focusing the student experience on success through student engagement*. Pretoria: Council on Higher Education

Strydom, J. F. & Mentz, M. (2010b). Enhancing success in South Africa's higher education: measuring student engagement. *Acta Academica, 42*(1), 259-278.

Sylva, K., Siraj-Blachford, I., & Taggart, B. (2003). *Assessing quality in the early years, early childhood environment rating scale extension.* London: Trentham.

Tanner, K., & Allen, D. (2004). Approaches to biology teaching and learning: learning styles and the problem of instructional selection: engaging all students in science courses. *Cell Biology Education*. *3*, 197-201.

Toohey, S. (1999). *Designing courses for higher education*. Buckingham: SRHE and Open University Press.

Theron, L., Mitchell, C., Smith, A., & Stuart, J. (Eds.). (2011). *Picturing research: Drawing as visual methodology*. Rotterdam: Sense.

Threadgold, T. 2003. Cultural studies, critical theory and critical discourse analysis: Histories, remembering and futures. *Linguistik Online, 14*(2/03), 1-33. Retrieved from http://www.linguistik-online.de/14_03/threadgold.html.

Tierney, J., & Brunton, E. 2005. *Learning styles: a factor in course choice. B.Sc. Project in Health & Leisure, Institute of Technology.* Tralee 2005.Retrieved from: https://www.ittralee.ie/en/ Information For/Staff/ Teaching and Learning Unit/Journals2006-2007/Title,15322,en.html.

Trigwell, K., & Prosser, M. (1991). Approaches adopted by teachers of first year university science courses. *Research and Development in Higher Education, 14*, 223-228.

Tulbure, C. (2011). Do different learning styles require differentiated teaching strategies? *Procedia Social and Behavioral Sciences, 11*, 155-159.

Van Schalkwyk, G. J. (2010). Collage life story elicitation technique: A representational technique for scaffolding autobiographical memories. *The Qualitative Report, 15*(3), 675-695.

Wang, M-T., & Eccles, J. S. (2012). Social support matters: longitudinal effects of social support on three dimensions of school engagement from middle to high school. *Child Development, 83*(3), 877-895.

Waldheim, G. P. (1987). Understanding how students understand. *EngineeringEducation, 77*(5), 306-308.

Waterworth, H. W., & Weddle, A. E. (1978). Bills of quantities for landscape works. *The Quantity Surveyor, 35*(1), 244-245.

Wheeldon, J., & Faubert, J. (2009). Framing experience: concept maps, mind maps, and data collection in qualitative research. *International Journal of Qualitative Methods, 8*(3), 52-67.

Wilcox, C., & Snape, J. A. (1980). *Measurement of Construction Work* (2nd ed.). London: Georse Godwin.

Willis, C.J., Newman, D. (1988). *Elements of Quantity Surveying*. (8th ed.). B P Professional Books.

Willms, J. D. (2003). *Ten hypotheses about socioeconomic gradients and community differences in children's developmental outcomes*. Hull, Quebec: Human Resources Development Canada. Retrieved from: http://publications.gc.ca/collections/Collection/RH63-1-560-01-03E.pdf.

Yin, R. (1994). *Case study research: design and methods* (2nd ed.). Beverly Hills, CA: Sage.

Yin, R. (2008). *Case study research: design and methods* (4th ed.). Beverly Hills, CA: Sage.

Zepke, N. (2013). Threshold concepts and student engagement: Revisiting pedagogical content knowledge. *Active Learning in Higher Education, 14*(2), 97-107.

Zepke, N., & Leach, L. (2010). Improving student engagement: ten proposals for action. *Active Learning in Higher Education, 11*(3), 167-177. doi: 10.1177/1469787410379680.

APPENDICES

A1: ETHICAL CLEARANCE CERTIFICATE

A2: EDITING CERTIFICATE

DR RICHARD STEELE

BA, HDE, MTech(Hom)
HOMEOPATH and EDUCATOR
Registration No. A07309 HM
Practice No. 0807524
Freelance academic editor

110 Cato Road
Glenwood, Durban 4001
031-201-6508/082-928-6208
Fax 031-201-4989
Postal: P.O. Box 30043, Mayville 4058
Email: rsteele@telkomsa.net

EDITING CERTIFICATE

Re: **Emmanuel Konadu-Yiadom**

Master's dissertation: **An exploration of quantity surveying students' engagement with engineering graphics and specification drawings**

I confirm that I have edited the main text of this dissertation and the references for clarity, language and layout. I was not asked to edit the Appendices. I am a freelance editor specialising in proofreading and editing academic documents. My original tertiary degree which I obtained at UCT was a B.A. with English as a major and I went on to complete an H.D.E. (P.G.) Sec. with English as my teaching subject. I obtained a distinction for my M.Tech. dissertation in the Department of Homeopathy at Technikon Natal in 1999 (now the Durban University of Technology). During my 13 years as a part-time lecturer in the Department of Homoeopathy I supervised numerous Master's degree dissertations.

Dr Richard Steele
27 November 2016
Electronic

A3: PERMISSION TO CONDUCT RESEARCH

Edgewood Campus

Private Bag X03

Ashwood

3605

18 March 2016

Dean of DCC

Sir,

My name is Mr. Emmanuel Konadu, I am a Masters student at the University of KwaZulu-Natal Edgewood campus. I am currently engaged in a research project entitled, "**An exploration Quantity Surveying Students' engagement with engineering graphics and specification drawings"**

The purpose of this study is to explore how and why N4 quantity surveying students engage with the assessing and processing information from engineering graphics and specification drawings the why the do.

I will collect data from the N4 QS students by multiple methods. These include task based activity, individual interviews, focus group discussion, collage making and concept mapping. Data collection will not imping on tuition time. The interview, focus group discussion, collage making and concept mapping sessions will be video recorded. The findings of the research will not be used for any purpose other than the study. The data will be stored by my supervisor and disposed of at the end of 5 years. Pseudonyms will be used to protect the identity of your institution as well as the identity of theN4 QS students. All information disclosed will be kept in confidence. The participation in this research is voluntary and should you find that you wish to withdraw or terminate your permission for the research, you may do so without any negative consequences.

Thank you.

Yours sincerely

Emmanuel Konadu

Should you have any queries you can contact my supervisors

Dr. A. Singh –Pillay

Telephone no: 031- 260 3672

Email: pillaya5@ukzn.ac.za

The following personnel from the research office may be contacted:

Mr Premlall Mohun Tel. No. 031 260 4557 Email: HssrecHumanities@ukzn.ac.za

Thank you for your contribution to this research.

Acknowledgement –Stakeholders

I _____ (full name) hereby confirm that I understand the contents of the document and the nature of the research project. I grant consent for students from my institution to engage in the research and for data to be collected at DDC. In doing this permission is:

(please tick appropriate block)

Granted	
Not granted	

I am aware that I am at liberty to withdraw permission, should I so desire, without any negative consequences.

_____

Signature of stakeholder

_____

Date

A3: PERMISSION TO CONDUCT RESEARCH

DCC CAMPUS
DURBAN COMPUTER COLLEGE

Durban Computer College (Pty) Ltd trading as
DCC CAMPUS
DCC FET INSTITUTION
DCC MATRIC SCHOOL

Registered with the Department of Higher Education as a private higher education institution under the Higher Education Act,1997.
Registration certificate no: 2000/HE07/004
REGISTRATION NO.: 2002/008189/07
(REGISTRATION NO.: 2008/FE071002 as per Certificate No. 293-P AND 2000/HE07/004 as per Certificate No. 044)
GRADE 12 REGISTRATION NO.:35421283 / EXAM CENTRE NUMBER: 5411251
PROVISIONALLY ACCREDITED BY UMALUSI FET 00079PA
SAQA NQF REGISTERED PROGRAMMES
COMPTIA INTERNATIONAL PARTNER
ACCREDITED TRAINING PROVIDER FOR THE INSTITUTE OF CERTIFIED BOOKKEEPERS
DIRECTOR: MR.V.JUGLAL

CAMPUS 1 (HEAD OFFICE)
DCC HOUSE
375 SMITH STREET
DURBAN
4001

CAMPUS 2
DCC HOUSE
384 SMITH STREET
DURBAN
4001

TEL: 0860 CALL DCC (0860 2255322) FAX: (031) 307 3412 EMAIL: info@dcccampus.ac.za

DATE: 29 MARCH 2016

Dear Mr. Konadu Yiadom

RE: Request for permission to conduct research at DCC campus with N4 quantity surveying students.

This letter serves to confirm that your request for permission to conduct research at DCC campus with N4 quantity surveying students is approved. I am aware that I am at liberty to withdraw permission, should I so desire, without any negative consequences and that pseudonyms will be used to protect the identity of the campus and the students.

I wish you well with your study.

Sincerely

Miss K. Juglal

DCC CAMPUS
REG WITH THE DEPT OF EDUCATION 00HC01
SAQA ACCREDITED
DCC HOUSE, 375 ANTON LEMBEDE STREET
P.O. BOX 48538, QUALBERT 4078
TEL: 031 304 2007 FAX: 031 307 3412

A4: INFORMED CONSENT N4 QS STUDENTS

Dear N4 Quantity Surveying Student

Informed consent letter

My name is Mr. Emmanuel Konadu. I am currently studying for the degree of Master of Education with the University of KwaZulu-Natal, Faculty of Education (Edgewood Campus). To meet the requirements for this degree, I am conducting a study titled "**An exploration Quantity Surveying Students' engagement with engineering graphics and specification drawings**"

I would, therefore, like to invite you to participate in this study. This invitation is informed by the fact that you are N4 QS students at DDC. This makes you the most appropriate potential participant in this study.

You will be involved in the following activities: task based activity, individual interview, focus group discussions, collage making and concept mapping. There will be at least three sessions of data collection over a period of two months. Please also note that date, time and venue for the sessions will be arranged in consultation with you at a later stage. These sessions will be organised during the time when you are not expected to be attending lectures so as to prioritise your studies.

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.

- Your identity will not be revealed in writing or otherwise. Pseudonyms will be used to ensure complete anonymity. You will be informed of the date and time of all research activities/sessions.

- Each data collection session may last for about 1hour. However the focus group discussion may last for about 30 minutes. Please be aware that the focus group discussion and other research activities will be video-recorded (with your permission).

- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.

- Data will be stored in my supervisor's office after data analysis and be destroyed after 5 years.

- You have a choice to participate, not to participate or stop participating in the research at any time. You will not be penalised for taking such an action.

- Your involvement is purely for academic purposes only, and there are no financial benefits involved.

- The results of the study and any publications arising from the study will be sent to you by email.

I may be contacted as follows:

Cell. No. 0834220857 :

e-mail: ekonaduyiadom1@gmail.com

My supervisor's contact details are:

Dr. A. Singh- Pillay

Pillaya5@ukzn.ac.za

Tel: 031 2603672

You may also contact the Research Office through:

P. Mohun

HSSREC Research Office,

Tel: 031 260 4557 E-mail: mohunp@ukzn.ac.za

Thank you for your contribution to this research.

DECLARATION

I…… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I hereby consent or do not consent to (Please mark your selection with a X)

	consent	Do not consent
Video recording		

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

Signature of participant Date

…… ……

A5: TASK BASED ACTIVITY AND MEMO

Task based activity

Refer to the diagram sheet (attached)

The foundation plan and section for an out-building are given (not to scale).

SECTION A

QUESTION 1(PRACTICAL QUANTITY SURVEYING)

SPECIFICATION

-Clear site 2m beyond the external walls.

-15 MPa concrete

-Brickwork in stretcher bond with cement clay

-Stock bricks internally

-Face bricks externally, TWO courses below ground level

-Assume any specification not shown

1.1 Take off the foundation up to the underside of the surface bed.
(50)

1.2 Square, abstract, reduce and bill the earthworks only.
(25)

SECTION B (ANALYSIS OF CONSTRUCTIONAL DETAILS)

QUESTION 2

2.1 A solid casement window with sashes and fanlights opening outwards is built

Into the center of a one-brick wall plastered only on the inside

Specifications

-top rails bottom rails and stiles are 52mm x 38mm

-Sill and transom are 114mm x 76mm

-Head is 76mm x 52mm

Sketch to any reasonable scale ,the following vertical section:

2.1.1 Through the head, the top rail of the fanlight and the soldier arch
(5)

2.1.2 Through the transom and the surrounding construction
(5)

QUESTION 3 (THEORY OF QUANTITY SURVEYING)

3.1 State FIVE functions of the quantity surveyor.
(5)

3.2 Describe chronologically the processes involved in the preparing the bill

of quantities.

(5)

3.3 State the general rule of abstracting as the appear in the

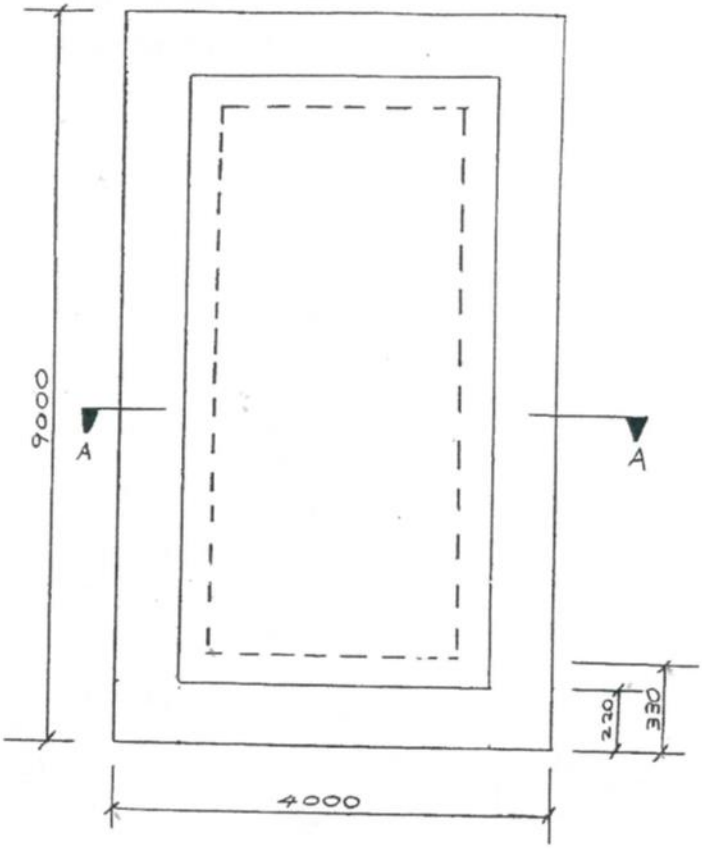
Latest edition of the standard system of measuring builder's work

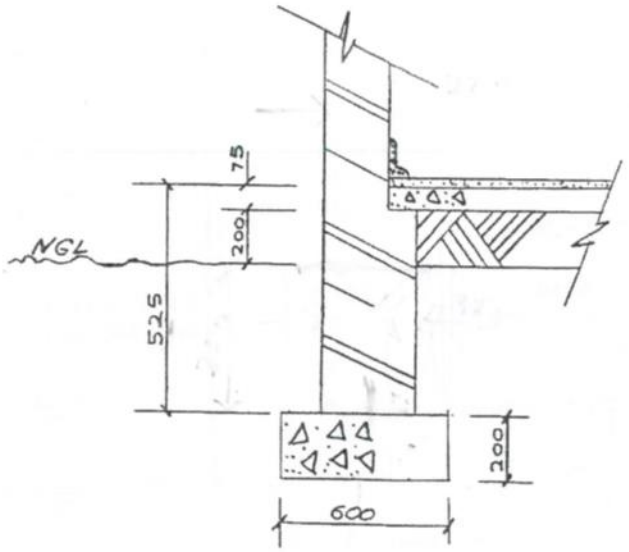
In South Africa

(5)

TOTAL 100

DIAGRAM SHEET





MEMORANDUM FOR QS N4 TASK BASED ACTIVITY

			MEASURING CHECK LIST FOR OUT BUILDING
			Site clearance ✓
			Excavation✓
			Risk of collapse ✓
			Risk of water ✓
			Concrete in surface trenches✓
			Brick wall in footings✓
			Backfill to trenches✓
			Cart away surplus soil ✓
			Hard core fill ✓
			Extra over ordinary bricks for external facing✓
			Clear site of all rubbish, debris etc. ✓
	8.00✓		L= +2/2000+4000=8000
	13.00✓	104.00	B=+2/2000+9000=13000
			Excavate in earth for surface trenches n.e. 2m in depth. ✓
	24.68✓		Center line = 2(4000+9000)-4/330=24680=L

	0.60✓		b=600,
	0.45✓	6.66	h=525+200-75-200=450
	Item✓	Item	Risk of water✓
			Risk of collapse to sides of trenches n.e 1.5m deep✓
2/✓	24.68✓		L=24680
	0.45✓	22.21	b=200+525-75-200=450
			15 MPa concrete in surface trenches for foundation footings. ✓
	24.68✓		L=24680
	0.60✓		b=600
	0.20✓		t=200
			One and half brick wall built in stretcher bond✓
	24.68✓		L=24680
	0.45✓		b=525-75=450
			Backfilling to sides of trenches
2/✓	24.68✓		L=24.68

	0,14✓		b=(600-330)÷2=135mm=0.14m
	0.25✓	1.73	h=525-75-200=250
			Cart away surplus material/ soil✓
			Add excavation 0f surface trench (**and**)
	24.68✓		
	0.60✓		
	0.45✓	6.66	
			1.
			Deduct backfill✓
2/✓	24.68✓		
	0.14✓		
	0.25✓	1.73	
			Earth filling to underside of surface bed(hard core fill) ✓
	3.34✓		
	8.34✓		
	0.20✓	5.57	

	26.00✓ 0.35✓		Extra over ordinary bricks for external facing✓ L=2(4000+9000)=26000 B=150+200=350 2.

Outbuilding ✓

M^2✓

Clare site of all

Rubbish, debris etc✓

104.00

104✓ 1✓

M^3✓

Excavate in earth for

Surface trenches n.e

2m deep✓

6.66 1✓

7.0✓

M^2✓

Risk of collapse to ✓

Sides of trenches

ABSTRACTOF EARTHWORK✓

M^3✓

Extra over excavation

for cart away✓

6.66 2✓ 1.73✓

1.73✓

4.93✓

5✓

M^3

Backfilling to sides of

trenches

1.73✓

2.0✓

MEMORANDUM

Item

Keep excavation free ✓

from water

Item✓

M^3✓

Earth filling to under

side of surface bed

5.57✓ 2✓

6.0✓

$\frac{30}{2}$ =15

n.e 1.5 m deep✓

22.21✓ 1✓

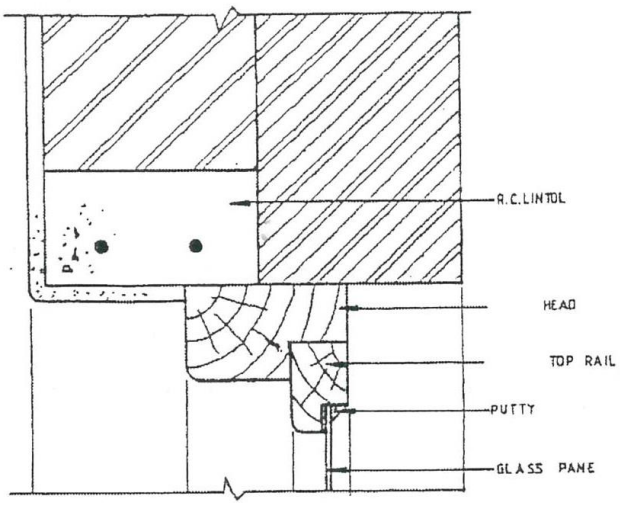
<u>22.0</u>✓

MEMORANDUM FOR BILLING OF EARTHWORK

n.o	Description✓	unit	qnt	rate	rand	cent
	EARTHWORK (OUTBUILDING) ✓ Bill no.1✓					
1	Excavate in earth for surface trenches✓	M^3	7✓			
2	Extra over excavation for cart away surplus materials✓	M^3	5✓			
3	Backfilling to sides of trenches✓	M^3	2✓			
4	Earth filling to underside of surface bed✓	M^3	6✓			
5	Clear site of all rubbish, debris as usual✓	M^2	104✓			
6	Risk of collapse to sides of trenches not exceeding 1.5 m Deep✓	M^2	22✓			
7		item	Item✓			

	Keep excavation free from water✓ Bill number one (1) carried to summary✓ $\frac{20}{2}$ =10					✓

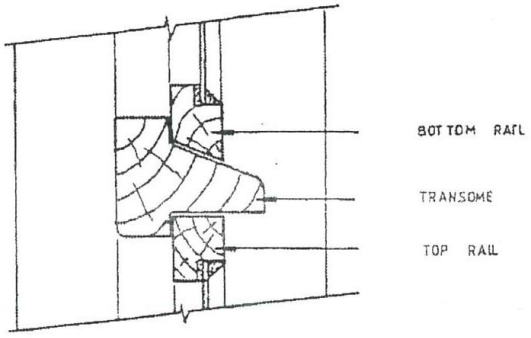
Head:



SECTION THROUGH WINDOW HEAD
SCALE : 1:2

Accuracy = 2
Labelling = 2
Linework = 1
5

Transom:



SECTION THROUGH TRANSOME
SCALE: 1:2

Accuracy = 2
Labelling = 2
linework = 1
5

Theory of Quantity Surveying Memo

3.1

- To estimate what the project will cost. ✓
- To prepare the bill of quantities. ✓
- Evaluate variation orders. ✓
- Prepares monthly interim valuation to pay workers of contractor. ✓
- Measures materials and labour from drawings prepared by the architect. ✓
- Prepare final accounts when project is completed. ✓
  (Any five)

3.2

- Study the drawings and specifications for taking off✓
- Check side casts, and squaring, ✓
- Abstract items and check the abstracts. ✓
- Working up the abstract, reducing and billing. ✓
- Typing and reading over the bill of quantities. ✓

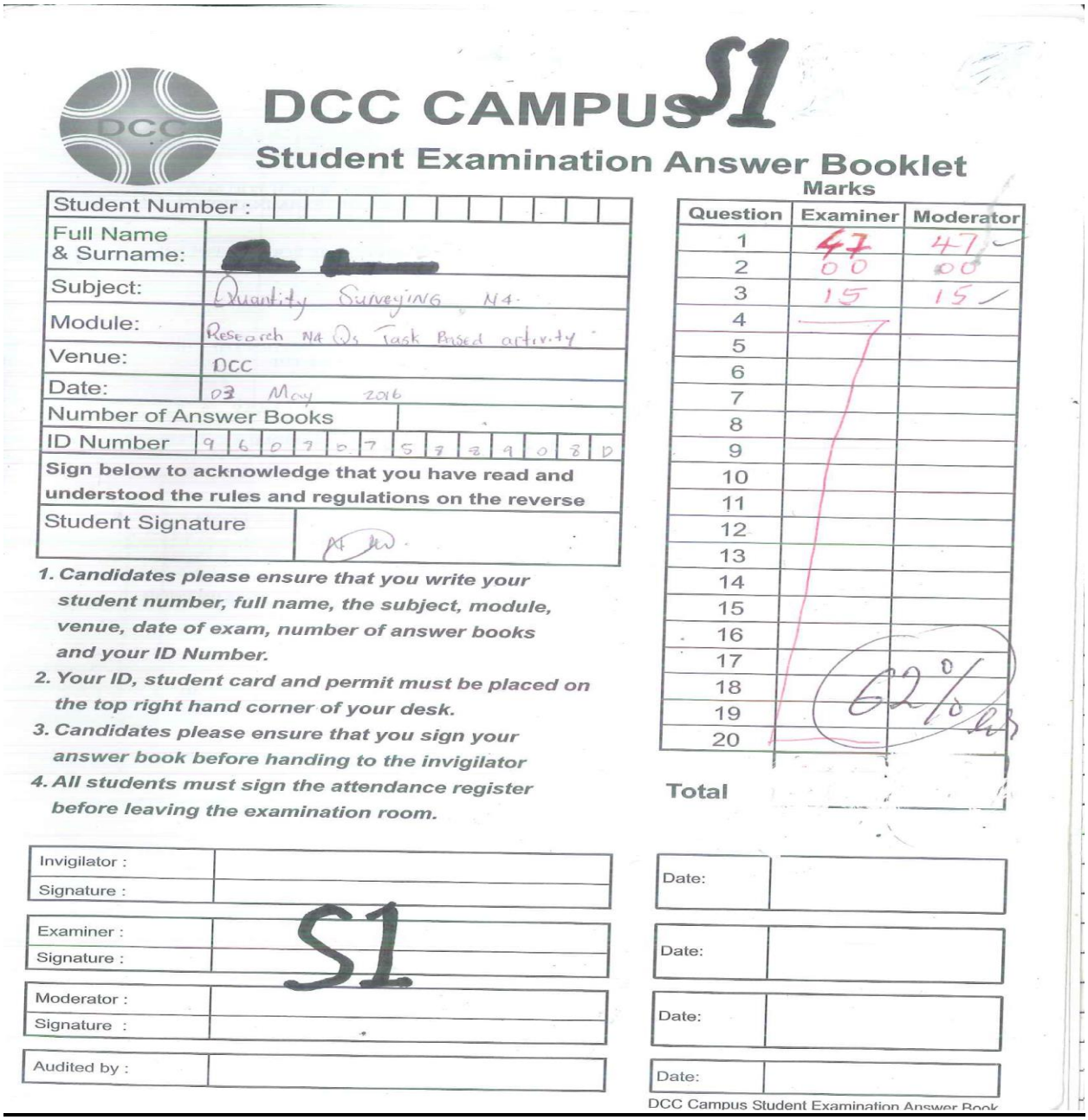
3.3

- Trades or sections are divided into subsections. ✓
- Within the subsections the order followed shall be mass, volume, area, length and number. ✓✓
- Subject to the 1 and 2, the item shall be placed in their approximate value, the cheapest first. ✓✓

A6: INDIVIDUAL INTERVIEW QUESTIONS

1. Please explain how to approached answering this particular question in the task based activity?
2. Why did you use the approached mentioned above?
3. What influences you to use these approaches to questions /solve problem pertaining to engineering and graphics and specification drawing?
4. Could you have used other ways to solve/interpret the questions posed?
5. Do you feel that you are ill equipped to answer question on engineering and graphics and specification drawing?
6. What can be done to equip you better to answer question on engineering and graphics and specification drawing?

A7: PARTICIPANTS' RESPONSES TO TASK BASED ACTIVITY AND MY COMMENTS



DCC CAMPUS S1

Student Examination Answer Booklet

Student Number :	
Full Name & Surname:	[redacted]
Subject:	Quantity Surveying N4
Module:	Research N4 Qs Task Based activity
Venue:	DCC
Date:	03 May 2016
Number of Answer Books	
ID Number	9 6 0 7 0 7 5 7 2 9 0 8 0
Sign below to acknowledge that you have read and understood the rules and regulations on the reverse	
Student Signature	[redacted]

1. Candidates please ensure that you write your student number, full name, the subject, module, venue, date of exam, number of answer books and your ID Number.
2. Your ID, student card and permit must be placed on the top right hand corner of your desk.
3. Candidates please ensure that you sign your answer book before handing to the invigilator
4. All students must sign the attendance register before leaving the examination room.

Marks

Question	Examiner	Moderator
1	47	47
2	00	00
3	15	15
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Total	62	

Invigilator :		Date:
Signature :		
Examiner :	S1	Date:
Signature :		
Moderator :		Date:
Signature :		
Audited by :		Date:

DCC Campus Student Examination Answer Book

BOE 8/11

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
DEPARTEMENT VAN HOËR ONDERWYS EN OPLEIDING

ABSTRACT PAPER
EKSERPEERPAPIER

1S

Candidate's number
Nommer van kandidaat

Outbuilding

EARTHWORK

Foundation Abstract

m²

Site clearance two metres beyond external walls

104 ✓ (1) ✗ page Ref

104 ✓ ?

m³

Excavation of Site trenches N.E 2m dp

6,66 ✓ (1) ✗ page ref

7 ✓

m²

R.O.C (full write item)

22,21 ✓ ?

22 (1) ✗ page ref

Item

R.O.W write in full

Item ✓ ?

m³

Back fill to trenches

1,73 ✓ ?

2

m³ ✓

Cart away of surplus soil

4,93 ✓ ?

5 ✓

m³

Hard core fill

4,93 (error)

5 ? NIL ✓

m³ ✓

Hard core fill

5,57 ✓

6. ✓ ?

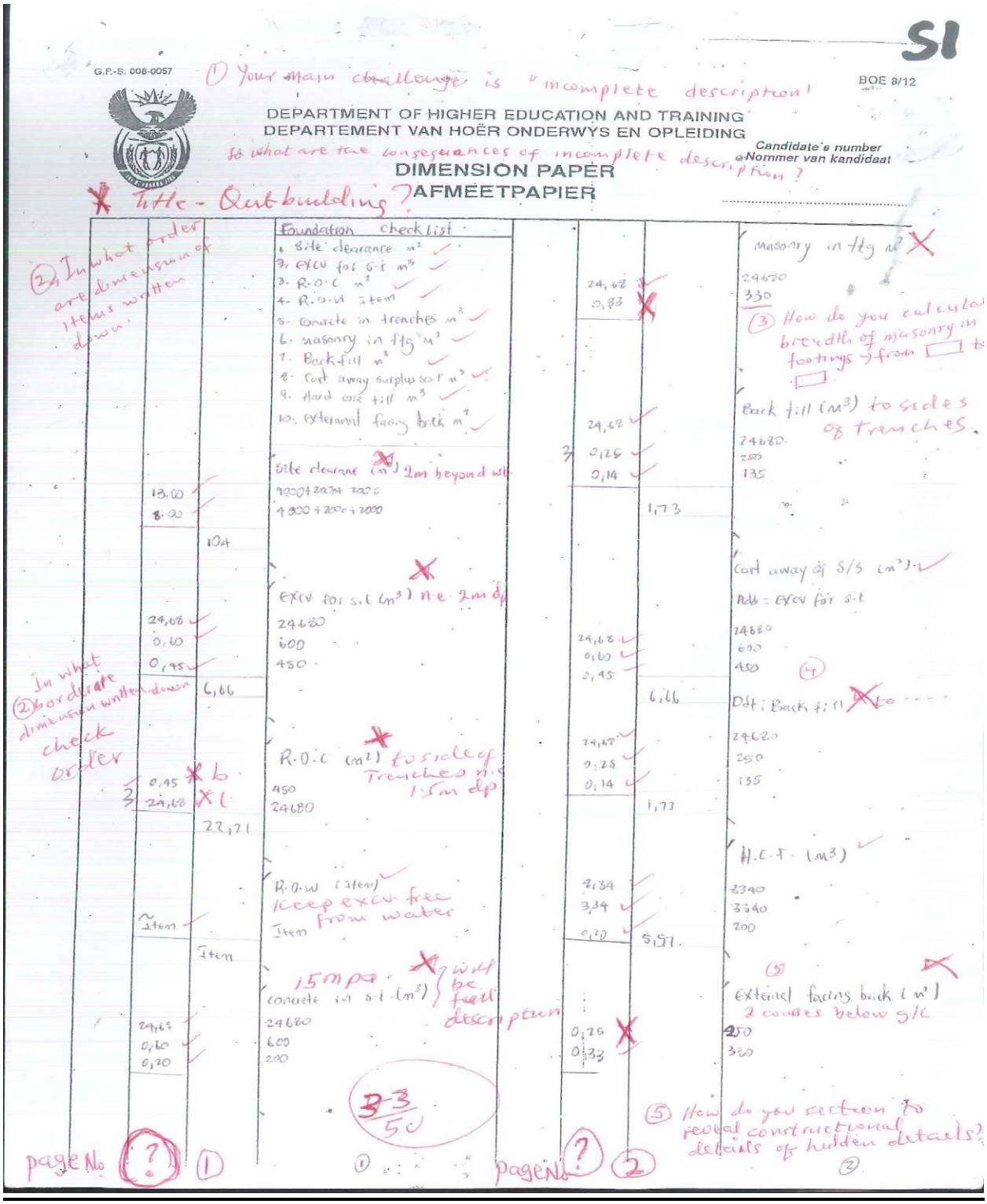
51

@ 16½ = 08½ = 09

2

Always

* Write the title of project in contract
* The Name of Trade under Abstract
* Reference all items abstracted.
* Underline all final answers



G.P.-S. 008-0057

BOE 8/12

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
DEPARTEMENT VAN HOËR ONDERWYS EN OPLEIDING

Candidate's number
Nommer van kandidaat

DIMENSION PAPER
AFMEETPAPIER

S1

(1) Your main challenge is incomplete description!
So what are the consequences of incomplete description?

Title - Outbuilding?

(2) In what order are dimensions of items written down.

Foundation checklist
1. Site clearance m^2
2. Excv for s.t m^3
3. R.O.C m^2
4. R.O.W item
5. Concrete in trenches m^3
6. masonry in ftg m^3
7. Back-fill m^3
8. Cart away surplus s.t m^3
9. Hard core fill m^3
10. External facing brick m^2

Site clearance (m^2) 2m beyond w
13.00
8.00
10,4
9200+2000+2000+2000
4800+2000+2000

Excv for s.t (m^3) n.e. 2m dp
24,68
0,60
0,45
6,66
24680
600
450

R.O.C (m^2) to side of Trenches n.e 1.5m dp
0,45 b
24,68 l
22,21
450
24680

R.O.W (item)
Item
Item
Keep excv free from water

15 mpa. concrete in s.t (m^3) will be fuller description
24,68
0,60
0,20
24680
600
200

33
50

page No ? 1

24,68
0,83
24,68
0,25
0,14
1,73
24,68
0,60
0,45
6,66
24,68
0,28
0,14
1,73
2,34
3,34
0,20
5,57
0,75
0,33

page No ? 2

masonry in ftg m^3
24680
330
(3) How do you calculate breadth of masonry in footings → from ☐ to ☐

Back fill (m^3) to sides of trenches
24680
250
135

Cart away o/s s/s (m^3)
Add: Excv for s.t
24680
600
450
(4)
Ddt: Back fill to ---
24680
250
135

H.C.F (m^3)
3340
3340
200

(5)
External facing brick (m^2)
2 courses below s/c
250
330

(5) How do you section to reveal constructional details of hidden details?

DCC CAMPUS

Quantity Surveying

51

Question 3.

3.1. a, Prepare the bill of Quantities. ✓

b, Prepare the variation order estimate. ✓

c, Prepare the tender documents. ✓ (5)

d, Prepare the final account. ✓

e, Measures the materials and labour from the drawings prepared by the architect.

3.2. a, Study the drawings with specifications for taking off. ✓

check side b, Casts side wags, Squaring and checking. 5

c, ~~Abstracting~~ Abstracting and checking the abstract. ✓

d, Working out the abstract, billing and checking the bills. ✓

e, Typing and reading the bill of quantities.

3.3. a, Trades or Sections must be divided into Sub-sections. ✓

b, Within all Sub-sections, the order followed shall be Mass, Volume area, length and number. ✓

c, Subject 1 and 2, the materials shall be placed according to their approximate value, the cheapest first. (5)

51

S2

DCC CAMPUS

Student Examination Answer Booklet

Student Number :	1 6 0 0 8 7
Full Name & Surname:	
Subject:	QS
Module:	Research Mu QS Task based Ad
Venue:	205
Date:	3 May 2016
Number of Answer Books	
ID Number	9 7 0 6 0 9 5 8 0 7 0 8 0

Sign below to acknowledge that you have read and understood the rules and regulations on the reverse

Student Signature	

1. ***Candidates please ensure that you write your student number, full name, the subject, module, venue, date of exam, number of answer books and your ID Number.***
2. ***Your ID, student card and permit must be placed on the top right hand corner of your desk.***
3. ***Candidates please ensure that you sign your answer book before handing to the invigilator***
4. ***All students must sign the attendance register before leaving the examination room.***

Marks

Question	Examiner	Moderator
1	13	13
2	00	00
3	10	10
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Total	23%	23%

23%

Invigilator :		Date:	
Signature :			
Examiner :		Date:	
Signature :			
Moderator :		Date:	
Signature :			
Audited by :		Date:	

DCC Campus Student Examination Answer Book

[redacted] S2 [redacted]

9706095807080 BOE 8/12

C.P.-S. 008-0057

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
DEPARTEMENT VAN HOËR ONDERWYS EN OPLEIDING

Candidate's number
Nommer van kandidaat

DIMENSION PAPER
AFMEETPAPIER

(5) Why do you ignore dimensions or corrections of underlying item

(1) Where is the check?

(2) Why don't you follow the order

L
b
h

(3) What are the effect of incomplete descriptions

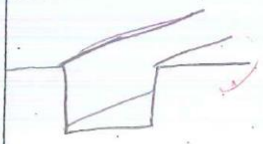
(4) What are the fuel factors for good description

	?	
	?	
0.60	b	
0.45	h	
24.68	L	
item		
0.13		
24.68		
0.60		
0.20		

Site clearance (1)

L = 4000 +

b = 2000 + 9000 + 2000



write complete sentences

Excavation of SE

b = 600

h = 525 + 200 − 75
= 250 + 200 = 450

L = 2600 − 1370
= 24680

R.O.W

R.O.C to sides of trenches

b = 600 − 330
= 270 ÷ 2
= 135

15MPa concrete in SE

L = 24680

b = 600

h = 200

Measure to two decimal place at all times

24.68	
0.25	
24.68	write in full
0.14	
0.25	
24.68	
0.60	
0.20	
?	
3.34	
8.34	
0.20	

NIL

Work value to 2 decimal places

~~1½ brick wall built in~~ masonry in ftg stretcher bond

L = 24680

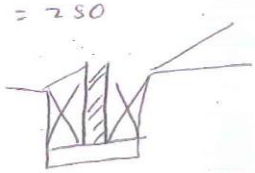
b = 525 − 75 − 200
= 250

Back fill to sides of trenches

L = 24680

b = 600 − 350
= 270 ÷ 2
= 135

h = 250



Cart away SS

L = 24680

b = 600

h = 200

(6) No cancellation is permitted what sign is used for cancellation

Brick work

L = 24680

b = ?

hard core fill to under side of surface bed.

L = 4000 − 660
= 3340

b = 9000 − 660
= 8340

h = 200

NIL

[redacted] [redacted]

S2 DCC CAMPUS

Question 3 [redacted]

3.1 - Prepare Bill of Quantities ✓
- prepare the variation order estimate ✓
- Prepare the tender documents ✓ (5)
Prepare the final account ✓
Measures the metrials and labour ✓

3.2. - Study ? the drawing with specifications ✓
- Meaning? (Side ways) squaring and checking the obstract
- obstraction and checking checking the abstract (03/05)
- working out the abstrack, billing and checking the bills
- Typing and reading the bill of quantities
You miss taking off by measuring work, labour, etc.

3.3 * Trades or Sections must be devided into Sub-section
* Within all Sub-sections, the order followed shall be Measured as follow : Area, lenght and numbers
* mass, volume, area, length, No, item

(02/05)

S2

(10/15)

Short comings
(1) No check list provided
(2) Poor incomplete description
(3) No abstracting
(4) No Billing
(5) Poor attendance and puntuality; very irregular in class !!

DCC CAMPUS

Student Supplementary Examination Answer Booklet

Student Number:	1 6 0 1 0 6
Full Name & Surname:	[redacted]
Module	Quantity Surveying (44/100)
Venue	305 / 384
Date	03 May 2016
Number of Answer Books	
I D Number	9 7 0 4 1 0 0 9 9 7 0 8 7
Sign below to acknowledge that you have read and understood the rules and regulations on the reverse	
Student Signature	[signature]

1. ***Candidates please ensure that you write your student number, full name, the subject/module, venue, date of exam, number of answer books and your I D Number***
2. ***ID, student card and permit to be placed on the top right hand corner of your desk***
3. ***Candidates please ensure that you sign your answer book before handing to the invigilator***
4. ***All students must sign the attendence register before leaving the examination room***

Marks

Question	Examiner	Moderator
1	34	34
2	00	00
3	10	10
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15	44	44
16		
17		
18		
19		
20		
Total	44%	44%

Invigilator: Name & Surname	
Signature	
Examiner:	
Signature	
Moderator:	
Signature	
Marks Captured by:	

S3

Date:	
Date:	
Date:	
Date:	

STA-SE-02

DCC Campus Student Examination Answer Book

53

① What are the consequence of incomplete descriptions

② what are the 5 factors to consider when writing good descriptions

G.P.-S. 008-0057

BOE 8/12

53

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
DEPARTEMENT VAN HOËR ONDERWYS EN OPLEIDING

Candidate's number
Nommer van kandidaat

DIMENSION PAPER
AFMEETPAPIER

160106

CHECKLIST FOR BUT-BUILDING

1. Site clearance
2. Excv. for s.t ne 2m dp
3. R.B.C
4. R.B.W
5. conc in s.t
6. brick work in footing
7. backfill to trenches
8. cart away surplus soil
9. Hardcore fill
10. External facing

Clear site of all debries etc

L = 2 000 + 4 000 + 2 000
= 8 000

B = 2 000 + 9000 + 2 000
= 13 000

8,00
13,00
104

2 Excv. for s.t n.e 2m dp

P = 2(L+b)
= 2(4000 + 9000)
= 2(13 000)
= 26 000

$\frac{1}{100}$ = 4 / 390
= 1,320

26000
− 1320
24 680

b = 600
h = 525 + 200 − 75 − 200
= 450

24,68
0,60
0,45
6,66

Item Item

3. Risk of water

4. Risk of collapse to sides of trenches n.e 1.5m deep

L = 24 680
b = 600

24,68
0,60
22,21

wrong.

24,68
0,45
7,407

24,68
0,60
0,45

(1)

20/50

(3) How do you calculate height/thickness of concrete in surface trenches

15 mpa

5. conc in s.t
L = 24 680
b = 600
h = ? = 300

6. brickwork in footing ?
L = 24 680
b = 200 + 525 − 75 − 200
= 450
t = ~~200~~

7. Backfill to trenches
L

(4) How do you measure backfill to sides of trenches

8. Hardcore fill to underside of surface bed.

(5) How to you measure hard core fill

(6) How do you measure cart away of surplus soil soil

cart away surplus soil
L = 24680
b = 600
h = 450.

(2)

53

BOE 8/11

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53

Candidate's number
Nommer van kandidaat

Ntombiyenkosi T. Mzobe

BILLING PAPER
LYSTEPAPIER

160106

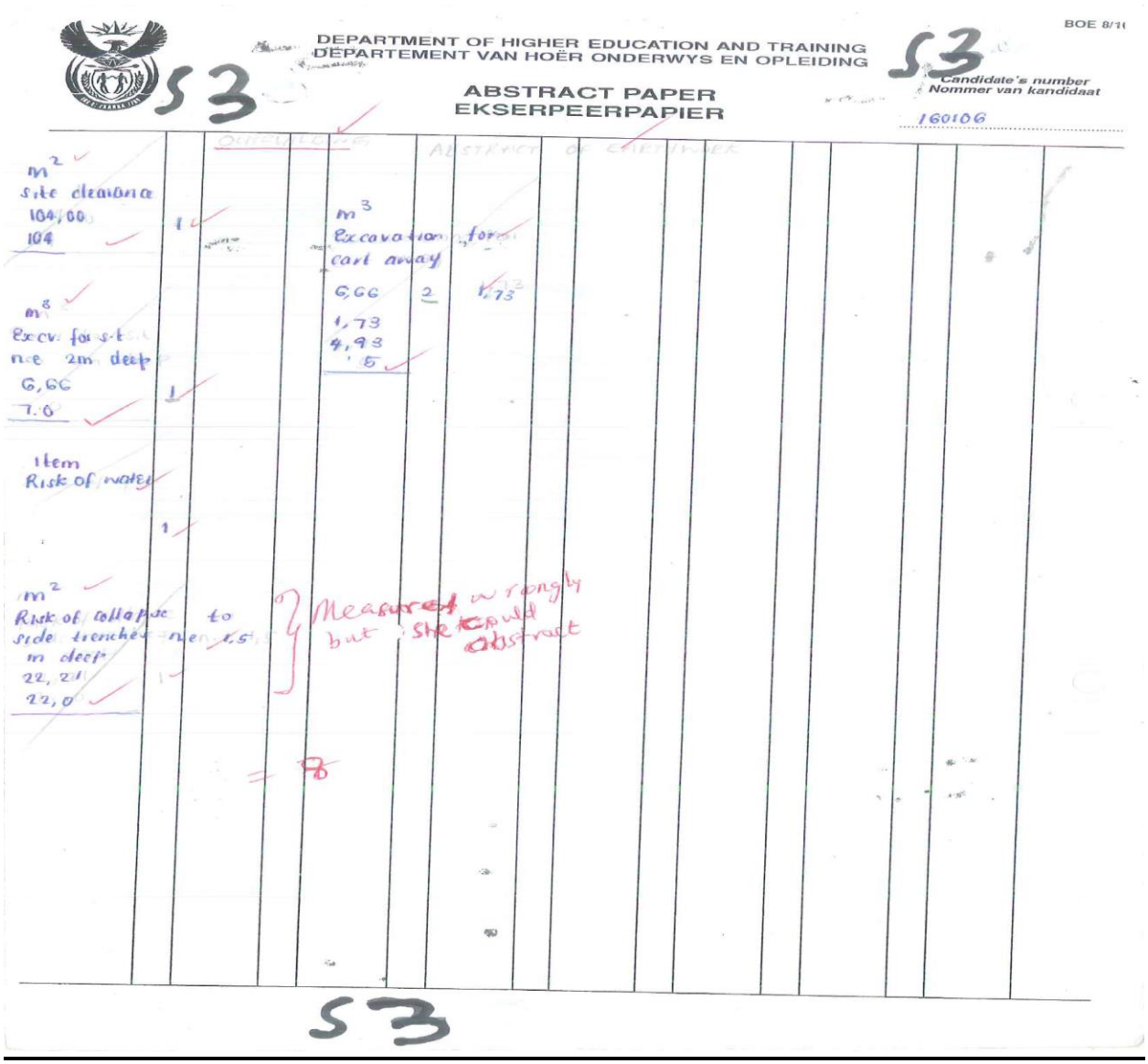
53

no.	Description Earthwork (OUTBUILDING)	unit	qnt	rate	rand	cent
1	Excvate in earth for surface trench	m^3	7,0?			
2.	Extra over excavate for cart away surplus metarial	m^3	5			
3.	Backfill to sides trenches	m^3	1			
4	Earth filling to underside of surface bed	m^3	?			
6.	clear ~~site~~ site of all rubbish	m^2	104?			
6.	Risk of collapse to side trenches 1.5 m deep	m^2	22			
7.	Risk of water	item				
	Bill No 1. carried to Summary					

$\frac{12}{2} = 6$

20
14
34
10
44

53



DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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BOE 8/1(

S3

ABSTRACT PAPER
EKSERPEERPAPIER

S3

Candidate's number
Nommer van kandidaat

160106

OUTSTANDING — ABSTRACT OF CENTIMETER

m²
site clearance
104,00
104

1

m³
Excavation for
cart away
6,66 2 1,73
1,73
4,93
5

m³
Excv. for strip
nce 2m deep
6,66
7.0

1

Item
Risk of water

1

m²
Risk of collapse to
side trenches men 1.5
m deep
22,21
22,0

1

Measured in roughly but sketch could Obstruct

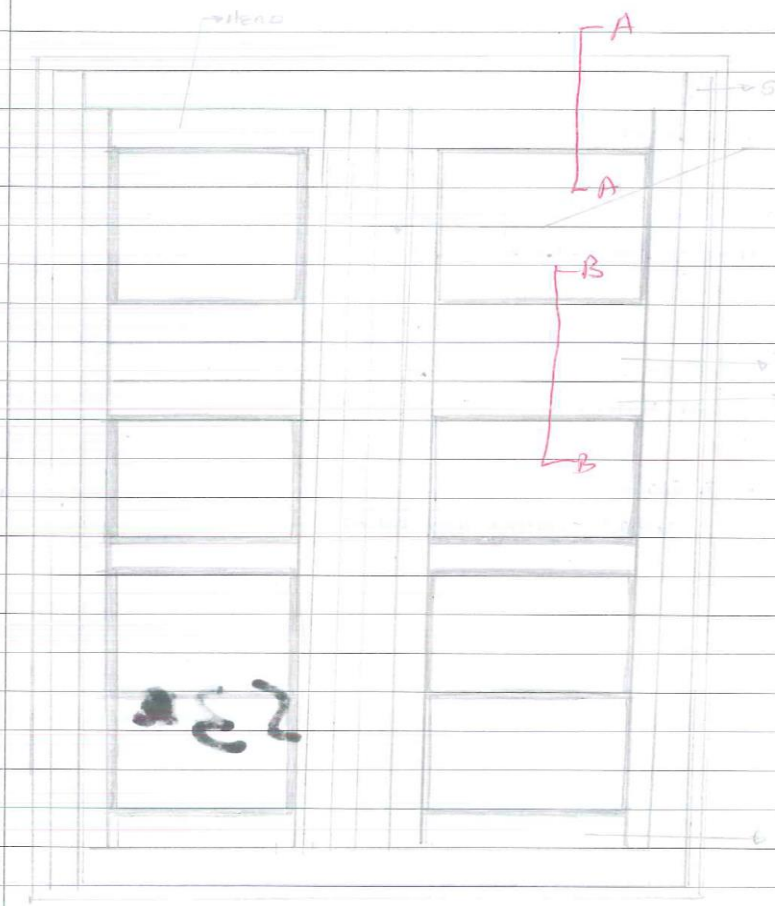
= 70

S3

DCC CAMPUS

S 3

Question 2.



S 2

S 3

DCC CAMPUS

Question 3.

3.1. Functions of a surveyor
- Prepares bill of quantities
- Estimate the cost of a project
- Prepares final account
- Prepare interim valuation
- Measure materials drawing from architect.

5

3.2. Study drawings and specifications
- Check side casts and squaring
- Abstract the items
- Reads over the bill of quantity
- Working on up the abstract, reducing and billing

5

3.3. 0

53

10

54

DCC CAMPUS

Student Examination Answer Booklet

Student Number :	1 6 0 0 9 5
Full Name & Surname:	[redacted]
Subject:	Quantity Surveying
Module:	M4 [Research Task Basic Activity]
Venue:	DCC College
Date:	03 May 2016
Number of Answer Books	
ID Number	9 7 0 1 3 1 0 5 2 8 0 8 2
Sign below to acknowledge that you have read and understood the rules and regulations on the reverse	
Student Signature	[redacted]

1. Candidates please ensure that you write your student number, full name, the subject, module, venue, date of exam, number of answer books and your ID Number.

2. Your ID, student card and permit must be placed on the top right hand corner of your desk.

3. Candidates please ensure that you sign your answer book before handing to the invigilator

4. All students must sign the attendance register before leaving the examination room.

Marks

Question	Examiner	Moderator
1	25	25
2	00	00
3	14	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Total	39%	39%

Invigilator :		Date:
Signature :		
Examiner :		Date:
Signature :		
Moderator :		Date:
Signature :		
Audited by :		Date:

54

DCC Campus Student Examination Answer Book

Name: [redacted]

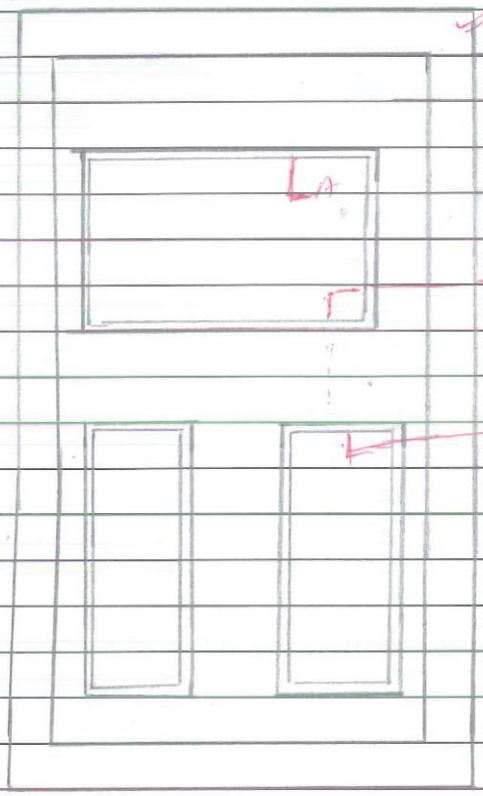
DCC CAMPUS

54

Section B

Question 2

2.1.

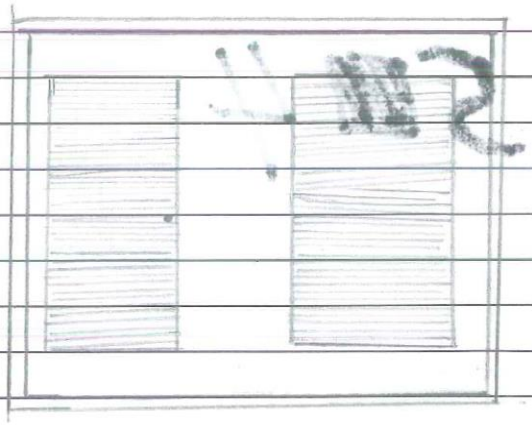


Use the cutting plane to show sections

A – A

B – B

2.2.



You are required to draw vertical sections (i) A – A

(ii) B – B shown in your sketch

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Question 3.

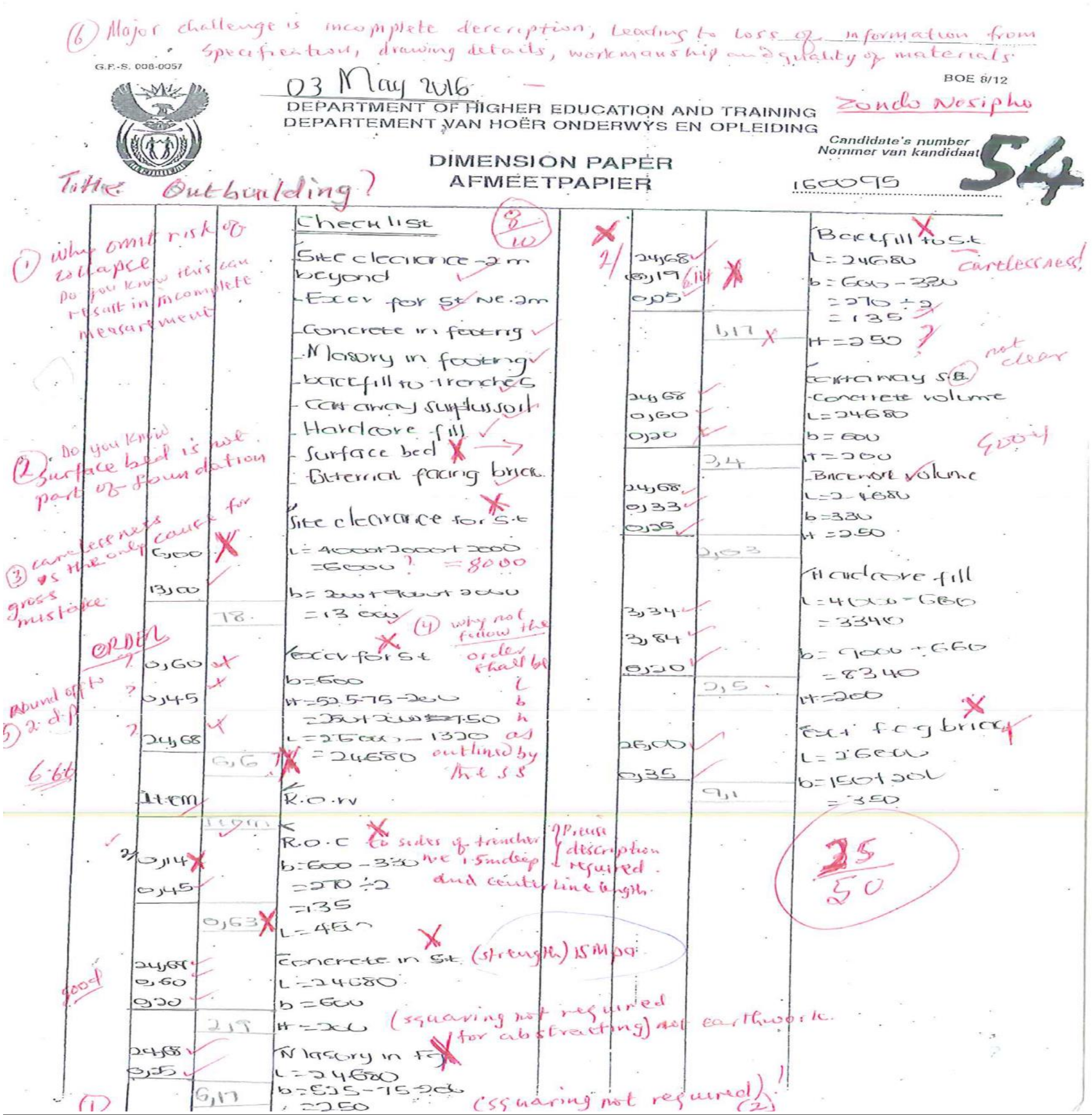
3.1 a) Prepare the bill of quantities ✓
b) Prepare variation orders estimate ✓
c) Prepare the final payment estimate ✓
d) Prepare interim payment ✓
e) Prepare the tender documents ✓ (5)

3.2 a) Study the drawings with specification, taking off ✓
b) Cost sideways, squaring and checking ✓
c) Abstracting and checking the abstract ✓ (5)
d) Pricing out the abstract, billing and checking the bills ✓
e) Typing and reading the bill of quantities ✓

3.3 a) Structure or Sections must be divided into Sub-sections ✓
b) Subject to no. 2, the materials shall be placed according to their approximate value, the cheapest first ✓
c) Within all Sub section, the order followed shall be value, Area, length and number ✓ (4)
d) You must number it correctly, don't do the mistake
e) Make sure that it is seen clearly

14/15

5 4



(6) Major challenge is incomplete description, leading to loss of information from specification, drawing details, workmanship and quality of materials.

G.F.-S. 008-0057

03 May 2016

BOE 8/12

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
DEPARTEMENT VAN HOËR ONDERWYS EN OPLEIDING

Zondo Nosipho

Candidate's number
Nommer van kandidaat

54

DIMENSION PAPER
AFMEETPAPIER

Title: Outbuilding?

160095

Checklist 8/10

Site clearance – 2 m beyond
Excv for St NE. 2m
Concrete in footing
Masonry in footing
Backfill to trenches
Cart away surplus soil
Hardcore fill
Surface bed
External facing brick

(1) Why omit risk of collapse? Do you know this can result in incomplete measurement

(2) Do you know surface bed is not part of foundation

(3) carelessness is the only cause for gross mistake

(4) why not follow the order shall be as outlined by Art 33

(5) Round off to 2 d.p.

ORDER

Site clearance for S.t
L = 4000+2000+2000 = 8000
b = 2000+9000+2000 = 13 000

Excv for S.t
b = 600
H = 525–75–200 = 250+200 = 450 (?)
L = 25 000 – 1320 = 24 680

Item
R.o.c to sides of trenches n.e. 1.5m deep — Precise description required and centre line length.
b = 600 – 330 = 270 ÷ 2 = 135
L = 450

Concrete in S.t (strength) 15 MPa
L = 24 680
b = 600
H = 200 (squaring not required for abstracting) not earthwork.

Masonry in F.
L = 24 680
b = 525 – 75 – 200
= 250
(squaring not required)

Backfill to S.t
L = 24 680
b = 600 – 330 = 270 ÷ 2 = 135 — carelessness!
H = 250 ?

Cart away S.B. — not clear
Concrete volume
L = 24 680
b = 600
H = 200 — Good

Backfill volume
L = 24 680
b = 330
H = 250

Hardcore fill
L = 4000 – 660 = 3340
b = 9000 – 660 = 8340
H = 200

Excv f.c.g brick
L = 25 000
b = 150 + 200 = 350

good

25/50

132

G.P.S. 003-0110

03 May 2016

5 4

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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BILLING PAPER
LYSTEPAPIER

Candidate's number
Nommer van kandidaat 160095

No | Description | Unit | Qnt | Rate | Rm | Cent

Outbuilding (build no 1

Description
Earthworks

1	Site clearance	M^2	78		
2	Excavate for surface trenches	M^3	6,5		
3	Risk of water	Item	Item		
4	Risk of collapse to sides of Trenches	M^2	6,63		
5	Back-fill to trenches	M^3	1,17		
6	Cart away surplus soil	M^3	2,4		
7	Hardcore fill	M^3	2,5		

Bill no 1
carried to summary

$\frac{10}{2} = 5 - 2 = (3)$

Order of Items
mass (kg)
M^3
M^2
M
No
Item

54

03 May 2016

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
DEPARTEMENT VAN HOËR ONDERWYS EN OPLEIDING

BOE 8/1

54

Candidate's number
Nommer van kandidaat

160075

ABSTRACT PAPER
EKSERPEERPAPIER

Out building [Earthworks]

M^2
Site clearance
78.00
78m²
(positive marking)
page?
Information from which page of Dimension Sheet.

M^3
Exc for st. NF
2m deep
6,6
7m³
page?

M^2
Risk of collapse to sides of trenches
0,63
1m²
page

M^3
Cart away surplus soil
2,4
2m³
? page

Item
Risk of water — keep excavation free from water
Item
Item
page — use correct description

M^3
Backfill to trenches
1,17
1m³

M^3
Hard core fill — Earth filling to underside of trenches
2,5
3m³
page

12/2 = 6 = (3)

Always (1) Page your dimension paper
(2) Quote the page from where you took information on to the Abstract paper

54

DCC CAMPUS

Student Examination Answer Booklet

Student Number :	1 6 0 0 5 7
Full Name & Surname:	
Subject:	Quantity Surveying.
Module:	
Venue:	DCC CAMPUS
Date:	03/05/2016
Number of Answer Books	
ID Number	9 7 0 5 1 2 5 4 5 3 0 8 9
Sign below to acknowledge that you have read and understood the rules and regulations on the reverse	
Student Signature	

1. ***Candidates please ensure that you write your student number, full name, the subject, module, venue, date of exam, number of answer books and your ID Number.***
2. ***Your ID, student card and permit must be placed on the top right hand corner of your desk.***
3. ***Candidates please ensure that you sign your answer book before handing to the invigilator***
4. ***All students must sign the attendance register before leaving the examination room.***

Marks

Question	Examiner	Moderator
1	38	38
2	00	00
3	05	05
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		43%
19		
20		
Total	43%	

Invigilator :	
Signature :	
Examiner :	
Signature :	
Moderator :	
Signature :	
Audited by :	

Date:	
Date:	
Date:	
Date:	

DCC Campus Student Examination Answer Book

G.P.-S. 008-0057

55

Why don't you write your name?

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
DEPARTEMENT VAN HOËR ONDERWYS EN OPLEIDING

Candidate's number
Nommer van kandidaat

/55

DIMENSION PAPER
AFMEETPAPIER

(1) How will consultants/contractor know the project title?

TITLE OF PROJECT: OUTBUILDING

(2) How do you square site clearance?

(3) How do you calculate height of excavation

(4) List 5 factors of good description

(5) How do you calculate backfill?

(6) Why don't you use calculate to squared item?

(7) List 5 factors to consider when writing good descriptions

		Site clearance ✓	
		Excav for S.b. ✓	
		R.O.W ✓	
		R.O.C. ✓	
		concrete in footing ✓	
		masonry in footing ✓	
		back fill to trenches ✓	
		cart away S.S. ✓	
		Hard core fill ✓	
		External facing Bricks ✓	
		Site clearance 2m beyond perimeter wall.	
		L = 2000 + 9000 + 2000 = 13000	
	13,00 ✓		
	8,00 ✓	B = 2000 + 4000 + 2000 = 8000	
21 ? X			
		EXCV for S.b ne 2m dp	
	24,68 ✓	L = 24680	
	0,60 ✓	B = 600	
	0,75 X	H = 525 + 200 ? = 725	
26,03 X			
		R.O.W ✓	
ITEM ✓			
ITEM ✓		R.O.C (write full description	
	2/24,68 ✓	L = 24680	
	0,60 X	B = 600 X	
25,28 X			
		15M pa X concrete in footing	
	24,68 ✓	L = 24680	
	0,60 ✓	B = 600	
	0,20 ✓	H = 200	
	? ?	masonry in footing	
		L = 24680 ✓	
		B = 330 X	

Describe according to ① standard system.

		back fill to trenches	
	2/24,68 ✓	L = 24680	
	0,15 X	B = 600 - 330 = 270 ÷ 2 = 135 ✓	
	0,55 X	H = 525	
25,78 X			
		⑤ Do you know that cart away S.S. = Excv — Backfill	
		Hard core fill.	
		L = 4000 - 660 = 3340	
	8,34 ✓	B = 9000 - 660 = 8340	
	0,20 ✓	H = 200	
11,88 X			
		EXT facing brick X	
	24,68 ✓	L = 24680	(No need to square, why
	0,35 ✓	H = 350	
25,03 ?		B = 75	

⑥ What are the consequences of incomplete description according to specs, working drawing standard system?

30 - 5 / 50

NOTE, ALWAYS

(7) (1) write title of Contract Project
(2) write description according to
* standard system ④ drawing
* ② specification * construction method

8 Why is it important to write <title of project <title of trade ? during abstracting

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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55

TITLE: OUTBUILDING ABSTRACT PAPER
TRADE: EARTHWORK EKSERPEERPAPIER

Candidate's number
Nommer van kandidaat

m²
Site clearance
21 1
21

m²
Risk of collapse to sides of trenches not exceeding 2m. deep
25,28 1
25

m³
Excv for fdn n.e. 2m dp
26,03 1
26

m³
back fill to trenches
25,38 2
25

9/2 = 4½ = 5

Keep excavation free from water
Risk of water
1 term 1
1 term

m³
Hard core fill to the under side of ensuite bed
11,88 1/2
12

P1 (8) Remember to write
(1) Title of contract project
(2) Name of Trade you abstract
(3) Square accurately (You measured accurately but faltered in squaring?) why is this important
It is carelessness!!!

8 9 (4) Do you know
If squaring is not done accurately, no credible building can occur

55

G.P.-S. 008-0110

Name: 55

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TITLE: OUT BUILDING

TRADE: EARTH WORK

BILLING PAPER
LYSTEPAPIER

Candidate's number
Nommer van kandidaat .....

1	Site clearance 2m beyond perimeter walk	m^2 ✓	21 ✓			
2	Excv for surface trenches not exceeding 2m deep	m^3 ✓	26 ✓			
3	Risk of water ✓	item ✓	item ✓			
4	Risk of collapse ✓	m^2 ✓	25 ✓			
5	back fill to trenches ✓	m^3 ✓	25 ✓			
6	Hard core fill ✓	m^3 ✓	12 ✓			
	Bill No 1 carried to Summary					

(10) You forgot
(1) Title of Project
(2) Name of Trade
(3) Item numbers
(4) Order, ~~Mass~~, Volume, Area, etc

$\left(\frac{6}{2}\right) = 3$

(11) Warning
Abbreviation like excv (2) above are not allowed in the Billing

(12) Adhere to order of Billing for Items in the standard system page 1 clause 3 under general instructions

55

Question 3

3.1.- prepairs bill of quantities ✓
- prepairs the tender document. ✓
- prepairs variation order estimate ✓ (5)
- prepairs interim payments ✓
- prepairs the final payment estimate ✓

NOTE spelling
Prepares not Prepairs

(4) (10) Why do we use cutting planes?
- To show constructional details of materials that are hidden

Name of participant: .S2

No	Questions requirements	Correct response	Partially correct response	Incorrect response	No Response	Technique used to answer question	My Comments/ Remarks
1.1	Wrote title of project 'Outbuilding' on dimension paper					Poor	Title is ID of the Dimensions
	Provided the 10 checklist for taking off					Poor	Check list leaves nothing to memory
	Described nature of work to be done and quality of materials to be used accurately for the 10 measuring					Fair	Work need to be described accurately
	items of the foundation 1)Site clearance						
	2) Excavation of s.t.						
	3) R.O.C to side of t.						
	4)Risk of water 5)15 MPa conc. In s.t. 6) One and half bk wl.						

	7)Back fill						
	8)Cart away s/soil						
	9) H.f.c under s.b						
	10)Extra o.o.b for fcg						
	Made accurate assessment of engineering graphic and specification drawing and measured 10 foundation items accurately						Industry requirement
	Site Clearance						
	Excv of s.t.						
	R.O.C						
	Risk of water						
	15 MPa conc. In s.t.						
	One and half brk wl						
	Back fill						
	Cart away surplus soil						
	h.f.c under s.b						
	extra o.o.b for ex						
	t. facing						

	Wrote pages 1 and 2 on dimension sheet						To track origin of dimensions
1.2	Squared the 7 earthwork trade items accurately on dimension paper						Industry technique/Learner do not have technique
	Wrote title of project ‘’outbuilding’ on the abstract paper						Industry Practice -ditto-
	Wrote trade name ‘Earthwork’ on the abstract paper						Industry practice
	Abstracted the 7 Earthwork trade items successfully						Industry practice
	Made accurate referencing of all the 7 earthwork trade items						Recognise earthwork trade items only

	Wrote title of project 'Outbuilding' on dimension paper						Industry require ment
	Wrote name of trade 'Earthwork' on billing paper						Industry requirement
	Wrote "Bill no. 1' on billing paper						Earthwork items is being billed
	Wrote all Earthwork items in their right order, with reduced quantities and units						Require ment
	Carried bill no.1 to summary						Standard System requirement
2.1.	Made accurate sketch through head, top rail, fanlight and soldier arch of casement window						Requirement
2.2	Made accurate sketch through the transom and surrounding constructions						Drawing Skills
3.1	Stated 5 functions of the quantity surveyor						Drawing skills
3.2	Described chronologically the processes involved in preparing the bill of quantities						Theory of survey

3.3	Stated the rule of abstracting as they appear in the latest edition of the Standard System of measuring builder's work in South Africa,						Practical theory
							Standard System not familiar to learner

PARTICIPANTS RESPONSES AND MY COMMENTS ON THEIR RESPONSES (3C)

Name of participant: .S5

No	Questions requirements	Correct response	Partially correct response	Incorrect response	No Response	Technique used to answer question	My Comments/ Remarks
1.1	Wrote title of project 'Outbuilding' on dimension paper						Technique used to answer question
	Provided the 10 checklist for taking off						Office practice requirement
	Described nature of work to be done and quality of materials to be used accurately for the 10 measuring						nothing left to memory 'trusted'memory
	items of the foundation 1)Site clearance						
	2) Excavation of s.t.						
	3) R.O.C to side of t.						

	4)Risk of water						
	5)15 MPa conc. In s.t. 6) One and half bk wl.						
	7)Back fill						
	8)Cart away s/soil						
	9) H.f.c under s.b						
	10) E.o.o.b for ext.fcg.						
	Made accurate assessment of engineering graphic and specification drawing and measured 10 foundation items accurately						Industry requirement
	Site Clearance						
	Excv of s.t. R.O.C						
	Risk of water						
	15 MPa conc. In s.t.						
	One and half brk wl						

	Back fill						
	Cart away surplus soil						
	h.f.c under s.b						
	extra o.o.b for ext. facing						
	Wrote pages 1 and 2 on dimension sheet						Accurate reading of drawing plus quantitative techniques/learners has poor technique
1.2	Squared the 7 earthwork trade items accurately on dimension paper						Industry technique/Learner do not have technique
	Wrote title of project ‘’outbuilding’ on the abstract paper						Industry Practice -ditto-

	Wrote trade name 'Earthwork' on the abstract paper						Industry practice
	Abstracted the 7 Earthwork trade items successfully						Industry practice
	Made accurate referencing of all the 7 earthwork trade items						Recognise earthwork trade items only
	Wrote title of project 'Outbuilding' on billing paper						Industry require ment
	Wrote name of trade 'Earthwork' on billing paper						Industry requirement
	Wrote "Bill no. 1' on billing paper						Earthwork items is being billed
	Wrote all Earthwork items in their right order, with reduced quantities and units						Require ment
	Carried bill no.1 to summary						Standard System requirement
2.1.	Made accurate sketch through head, top rail, fanlight and soldier arch of casement window						Requirement
2.2	Made accurate sketch through the transom and surrounding constructions						Drawing Skills

3.1	Stated 5 functions of the quantity surveyor						Drawing skills
3.2	Described chronologically the processes involved in preparing the bill of quantities						Theory of survey
3.3	Stated the rule of abstracting as they appear in the latest edition of the Standard System of measuring builder's work in South Africa,						Practical theory
							Standard System not familiar to learner

PARTICIPANTS RESPONSES AND MY COMMENTS ON THEIR RESPONSES(6F)

Name of participant: .S1

No	Questions requirements	Correct response	Partially correct response	Incorrect response	No Response	Technique used to answer question	My Comments/ Remarks

1.1	Wrote title of project 'Outbuilding' on dimension paper						Technique used to answer question
	Provided the 10 checklist for taking off						Office practice requirement
	Described nature of work to be done and quality of materials to be used accurately for the 10 measuring						nothing left to memory 'trusted'memory
	items of the foundation 1)Site clearance						
	2) Excavation of s.t.						
	3) R.O.C to side of t.						
	4)Risk of water						
	5)15 MPa conc. In s.t. 6) One and half bk wl.						
	7)Back fill						
	8)Cart away s/soil						
	9) H.f.c under s.b						
	10) E.o.o.b for ext.fcg.						

	Made accurate assessment of engineering graphic and specification drawing and measured 10 foundation items accurately						Industry requirement
	Site Clearance						
	Excv of s.t. R.O.C						
	Risk of water						
	15 MPa conc. In s.t.						
	One and half brk wl						
	Back fill						
	Cart away surplus soil						
	h.f.c under s.b						
	extra o.o.b for ext. facing						

	Wrote pages 1 and 2 on dimension sheet						Accurate reading of drawing plus quantitative techniques/learners has poor technique
1.2	Squared the 7 earthwork trade items accurately on dimension paper						Industry technique/Learner do not have technique
	Wrote title of project ‘’outbuilding’ on the abstract paper						Industry Practice -ditto-
	Wrote trade name ‘Earthwork’ on the abstract paper						Industry practice
	Abstracted the 7 Earthwork trade items successfully						Industry practice
	Made accurate referencing of all the 7 earthwork trade items						Recognise earthwork trade items only

	Wrote title of project 'Outbuilding' on billing paper						Industry require ment
	Wrote name of trade 'Earthwork' on billing paper						Industry requirement
	Wrote "Bill no. 1' on billing paper						Earthwork items is being billed
	Wrote all Earthwork items in their right order, with reduced quantities and units						Require ment
	Carried bill no.1 to summary						Standard System requirement
2.1.	Made accurate sketch through head, top rail, fanlight and soldier arch of casement window						Requirement
2.2	Made accurate sketch through the transom and surrounding constructions						Drawing Skills
3.1	Stated 5 functions of the quantity surveyor						Drawing skills
3.2	Described chronologically the processes involved in preparing the bill of quantities						Theory of survey

3.3	Stated the rule of abstracting as they appear in the latest edition of the Standard System of measuring builder's work in South Africa,						Practical theory
							Standard System not familiar to learner

A8: INTERVIEW TRANSCRIPTS

Transcribed one-on- one Interview with participants

Name: Code:S2.

On Measurement on Dimension paper

Unstructured interview questions		5E Body language	My reflections/ interventions
1) Why did you not write the title of project" outbuilding "on dimension paper?	I…..I really did not see the need, nor figure it was important.	She places hand on face laughing	The title of project being measured must be written on the dimension paper, so that paper can be traced when mingled with other papers
2)Site clearance length in dimension column wrongly recorded, why did you not follow the order of recording dimensions as recommended by the Standard System	I was careless	She fidgets and chews thumb/fingers	You need to be careful when measuring
3) Are you aware your description 'Site clearance for s.t. is incomplete and wrong?	Not really		The Standard System Earthwork clause 4,page 6,makes it clear a brief description of the nature of vegetation (rubbish and Debris etc) shall be given.
In describing concrete in footing why did you leave the crucial strength of concrete out in your description?	I didn't know the strength of concrete (15MPa) is important to be included in describing concrete in footings or concrete to be used elsewhere.	She squeezes her face and rubs back of neck with hands	The Standard System trade item concrete, formwork and reinforcement, Clause 1, page 13, make it clear 'concrete shall be classified according to grade (strength) or mix, as strength of concrete always affect the safety and quality and ultimate cost of structure.

<table>
<tr>
<td>5)What things/ factors must you consider if you want to formulate “good” descriptions for quality work and material in Quantity Surveying? Have you seen the Standard system before and know its uses?</td>
<td>I haven’t seen the Standard system,…..Oh I remember you’ve shown it to us before, but I haven’t read it to find out its uses.</td>
<td>She is taken aback by the question. She recollects her thought to answer the question</td>
<td>You can formulate good description based on the recommendations of;
1) Standard System
2) Specifications
3) Working drawings
4) Constructional details
5) Unambiguous English
As up and coming professionals in QS , you need to have your own Standard System. In N5 and N6 examination if you don’t have the Standard System , you may not be allowed into the Examination</td>
</tr>
<tr>
<td>6) In recording the dimension for excavation you changed the order of writing the Dimensions, Why?</td>
<td>I thought , if the dimensions are correct they can be written in any order you like, and it will be alright</td>
<td></td>
<td>The Standard System General Instruction clause 4 explicitly lists the order of dimension to be written as follows:1) horizontal at right angles to the line of sight,2)horizontal parallel to the line of sight, and 3) Vertical. Hence all dimensions are written following this order.</td>
</tr>
<tr>
<td>7)Do you know how to calculate the center line as the length of risk of Collapse?</td>
<td>Yes, I do.
My use of 0.14 for the center was a mistake. I should have used 24.68, but I was not sure!</td>
<td>She points on her dimension sheet to show center line calculation</td>
<td>Ok, I see you’ve done it.
The r.o.c has two dimensions, length, and breadth. And should be recorded as such.
2/✓ | 24.68✓ 0.45✓ | 22.21✓</td>
</tr>
<tr>
<td>8)Why use 0.14 for the Length? Yours squaring is also wrong?</td>
<td>Yes, because I used 014x 0, 45=0.63.x
I have done it on my dimension sheet</td>
<td>She points to her dimension sheet</td>
<td>You were careless in recording your answers which were calculated right anyway!</td>
</tr>
</table>

9)How do you Calculate back fill to sides of trenches			

Questions and responses on Abstracting

Unstructured interview questions	Transcribed 5E responses	Observed Body language	My Reflections
1a) Look onto your dimension paper. Why did you not page your dimension paper? 1b) And because you did not page your dimension paper, you could not reference the information you recorded on the abstract paper to show their origin?	It was a mistake, I did not page my work on the dimension paper, and hence, I could not reference my work (Earthwork of Outbuilding) on t he abstract paper	She pulls her abstract paper, observe mistakes, and firms lips as she looks closely at abstract paper.	None referencing of the abstract paper using page numbers from the dimension sheet is a serious shortcoming all QS students must avoid. Referencing the abstract paper by writing the page (1or 2)in the small column of the abstract paper provides clarity of the source and origin of figures and information recorded on the abstract paper.
2)Can you see that because of your squaring mistakes, almost all information on your abstract paper is wrong?	Yes I can see I can see(looking at the MEMO of Abstract and Dimension sheets)	She nibbles the tip of her finger nail as She looks at the MEMO and nods.	A complete and correct picture of what part of your dimension and abstract sheets without mistakes would look like is as can be seen on the MEMO I show you now.

Questions On Responses on Billing

Unstructured interview question	Transcribed 5E Responses	5E observed body language	My reflections
1) Because your squaring on dimension paper were wrong, you transferred them wrongly onto the abstract and billing sheets, hence your quantities on billing sheet were wrong? 2)The order of writing items on the billing sheets is also wrong?	Yes I'm unaware of the order This is the first time I'm hearing of it.		The Standard System gives the order of writing items as mass, volume, area ,and number.(Standard System Clauses,3.1;3.2;3.3 page 1)

Transcribed One-on one interview on task based Activity

Name: Code: S5

Unstructured Interview questions	Transcribed 3C responses	observed3c body language	My reflections
1) Do you know why it is important to write the title of project "Outbuilding' on the Dimension paper?	Ehhrr…I don't know. Until you explained to me, I did not consider what can happen in the office environment.		1)The title' Out building' should d be written on the dimension sheet to identify the paper in case of it getting mixed up with other documents in the office.
2) Your squaring of Site clearance is 21, and it is wrong instead of 104.00 which is correct .Why? What happened?	I simply added the dimensions instead of multiplying them		Yea. Squaring means you simply multiply the dimensions and record the answer in the squaring column of the dimension sheet
3) How do you calculate the height of excavation? Your calculated value of 0.75 is incorrect. The correct value is of 0.45	My calculation was done as this: H=525+200=725 and I got it wrong; not subtracting 75 surface bed and 200 H.F.C		The height of excavation is calculated as follows: H=525+200-75-200=450
4) Your description of R.O.C is incorrect, What do you think is the right description for this item?	He nods to acknowledge mistake….. I lifted the check list item as description I didn't know the Standard System requirement and the pricing and work effect	He nodded his head….. Surprised that check list item does not represent description!	4) The Description should be done as recommended by the Standard System Earthwork R.O.C item clause 10; page7.(the key word here is r.o.c n.e. 1.5m, and those exceeding 1.5m) since these two categories of depths will be charged and priced differently.
5)In describing concrete in footings, you left out the crucial			

strength of the concrete (15MPa) Why do you think this is a serious mistake			5) The crucial strength of concrete eg 15MPa;20Mpa;30MPa should always be given; as they affect price, strength and safety of structure(Standard System, Concrete, formwork and Reinforcement Item, clauses1 and 2; page13)
6) Your description of "masonry in footing" is wrong. Why do you think this so? Again your calculation for the breadth of masonry in footing (330) is wrong? What is the right calculation?	The mistake is using the checklist items to describe. I now know this should not be so. I got length / center line correct, but I could not figure out the breadth=525-75=450		6)Standard System Masonry item clauses 1 and 6 on page 18 State among other things 'Masonry work shall be classified according to the material and quality of the masonry unit, the bond and the composition of the mortar; clause 1;……the overall thickness and the thickness of the individual skins shall be stated' on quote. This is what has been described in the memo.
7) You failed to record the length and breadth of masonry in footing in the dimension column, What happened?	Ooohhh…….. I wanted to attempt it later, but…..time….. I took breadth as height and height as breadth, which was the mistake!		
8) How do you calculate the breadth and height of backfill to trenches?, your recorded(0.15 and 0.55) which are wrong?	I couldn't figure it out. I did not attempt the question		The backfill to sides of trenches is calculated and recorded as follows(See Memo) 2/ 24.68 0.14 1.73 0.25
9) How do you calculate cart away of	I got the height correct, but got the length wrong	He looks and points to script	The easiest and correct method is ADD excavation dimensions; and DEDDUCT

surplus soil from site to a place t.b.d.? 10) Your calculated length of the perimeter for extra over ordinary bricks for external facing is inaccurate. What is the accurate method that can be used to calculate the perimeter of extra over ordinary bricks for external facing? Questions on Squaring	Responses I've realised the practice can lead to the loss of the document at the office,	He points with both hands onto his script Body language	backfill to trenches. (See Memo) The perimeter of the external wall is the length for the item, extra over ordinary bricks for external facing, and it is calculated as follows: L=2(4000+9000)=26000 My Reflections
1) Once again the title of projects 'Outbuilding' and the title of trade 'Earthwork' were not written on your abstract paper, why? 2) Since your squarings were wrong on the dimension paper, it has affected the accuracy on the abstract sheet. Do you see the mistakes?	Yes, yes,…. I transferred the wrong data onto the abstract sheet. My squaring were wrong that's why all the Earthwork quantities on my abstract paper are wrong.	He feels Uncomfort-able at his mistakes	It is exactly the reason of los s of papers at the office that all document should be titled with the project name and the respective trade name You correctly referenced the source of your information on the abstract sheet by successfully transferring the page numbers from dimension sheet onto the abstract paper.

Question on the Billing Mistakes of 3C

Question	Transcribed 3C response	Body language	My reflections
1) The title of Project 'Outbuilding,' and the title of trade' Earthwork' were not recorded on billing paper, why? 2) The order of writing dimensions not followed?	My response is the same , not realizing the paper might get lost in the office maze of papers I didn't know. I will the relevant clause in the Standard System		It is important not to lose sight of the possibility happening at the office situation. The order of recording the billing is of items is in the Standard System page1, clause3 under general Instructions. Please read it!

Questions on question no, 2

Question	Dialogue	3C body language	My reflections
1)ou did not answer this question 2 at all. You were to sketch to any reasonable scale through the 'head' and 'transom' to show the constructional details of a solid casement window , built into one brick wall plastered only on the inside . What really happened?	Ndlazi(3C) That was new to me Emmanuel (Tr): but we have done this in class? Ndlazi(3C):I admit, this is new to me.	He (3C) listens as teacher explains	The use of the cutting plane to reveal the constructional detail of certain parts and portions of a structure for closer observations and sketching the detail for record purposes is an area that requires attention by educators and learners. The vertical cutting reveals a vertical sectional details, the horizontal plane reveals the plan. When used effectively , the practically detail of construction can be revealed, The best way to learn constructional details however is to do regular site visit to see work in progress at first hand

Participant: S3

Unstructured interview questions	Transcribed 3C responses	Body language	My reflections
How do you measure: 1) Backfill to trenches 2) Hardcore fill 3) Cart away of surplus soil	I didn't attempt any of these questions because I couldn't figure out the measurement on the drawings	She struggles to assess and process information from the drawings, but gives up in despair	In calculating the backfill' the center line is 24.68; 0.14 is the spread, while the height of backfill is 0.25 On cart away of surplus soil the formula is: Excavation of s.t. minus back fills to sides of trenches.

The setting out of the calculation and recording of the measurement is as set out below:

			Back fill to sides of trenches
2/	24.68		
	0.14	1.73	
	0.25		
			Earth filling to underside of surface bed(hard core fill)
			L=4000-330-330=334o
	3.34		B=9000-330-8340
	8.34		H=200
	0.20	5.57	
			Cart away of surplus material / soil from site to a place to be described
			ADD Excavation
			L=24.68
	24.68		B=0.60
	0.60		H=0.45
2/	0.45	6.66	**Deduc**t back fill to sides of trenches
	24		
	68		
	0.14		
	0.25	5.57	**N.B** The net quantities are found on the abstract paper.

Unstructured interview questions	Transcribed 2B responses	Observed 2B body language	My reflections
You made the following wrong and incomplete descriptions in respect to the measurement of the foundation: 1)clear site 2)Risk of collapse 3) Conc. In s.t. Can you figure out why the descriptions are inadequate and wrong?	Eeehrr…..No.		The formulation of good and complete descriptions are based on 6 factors: 1)The Standard System 2)The specification 3)Working drawings 4) constructional details 5) Any other thing costing money 6) Simple unambiguous English

A9: MY REFLECTIONS

My further Reflections

Many learners believe the measuring check list they put down for a section to be measured constitute the description of what will be measured, ignoring the 6 factors of good description listed above. This is far from the truth.

In the learner's description of 'clear site'; the follow up question is clear site of what? The Standard System provides a guidance to site clearance as stated in clause 4, page 6 as follows.

Site clearance(clause 4 page 6)

The digging up and removal of rubbish, debris, vegetation, hedges, shrubs, and trees not exceeding 200m girth, bush etc shall be given in square meters……..

The removal of larger trees shall be given in numbers, the girth around the trunk 1m high above ground level being stated, grouped in sizes exceeding 200mm and not exceeding500mm girth and thereafter in stages of 500mm.descriptions shall state whether roots are to be grubbed up and holes filled in. The removal of tree stumps shall be kept separate from trees, the girth being taken at the top of the stump if not exceeding 1m high.

The stripping or excavation of turf or vegetable soil to be preserved shall be given in square meters stating *the average depth and where it is to be deposited.*

From the above quote from the Standard System, it is clear that descriptions of items to be measured in quantity Surveying can not be done casually. Description, therefore, must be done to cover the actual nature of work, quality of work, quantity of work and materials involved and any other thing costing money must be described. The constant question to be asked when describing is, will that thing or activity cost money? If the answer is yes, then it must be described accordingly.

Taking all factors into consideration therefore, a brief, but suitable memo to the learner's(2b) descriptions will be as shown

2b's Incomplete description	Standard complete description

1)Clear site 2) risk of collapse 3)Conc. In s.t.	1)Clear site of all of all rubbish, debris, etc (standard System , Earthwork item, Clause 4, page 6) 2)Risk of collapse to sides of trenches not exceeding 1.5m deep(Standard System Earthwork trade item clause 10, page 7) 3) MPa concrete in surface trenches for foundation footings

In the standard complete description of risk of collapse to sides of trenches, the key word 'not exceeding 1.5m deep 'is critical to ascertaining work limit and its cost, at that level of depth. If the depth was to exceed 1.5, the correct description would be "risk of collapse to sides of trenches exceeding 1.5 not exceeding 3.0m) and priced according the work and labour cost involved.

The risk of collapse of excavations shall be given in square meters, and shall be measured to all sides of excavation ……..

Separate items shall be given for "bulk" and "trenches and holes" as well as for excavations from ground level to not exceeding 1.5m deep and from ground level to exceeding 1.5 m deep…….

Sources: Standard System, Earthwork item; clause 10, page7.

In describing concrete in surface trenches for foundation footings, the crucial strength of the *concretegrade or mix of 15 MPa* cannot be glossed over as they will affect price, strength and quality of the structure.(Standard System, Concrete trade item clause1, page 13.

Billing questions

1) Why didn't you transfer your reduced quantities from the abstract paper onto the billing sheet?	Time…….		The reduced quantities is what is required as the final out of the bill of quantities, and every thing must be made to complete this section of the billing work.

My Reflections On task based activity for S2

Participating candidate number :S2

Personal details:

Sex; Male Level: N4

Date: July 2016-07-17

S2 scored 23/100 in the task based activity. He also spent 30 minutes in the interview.

Personal challenges are as follow:

1; **Non provision of check list to measure foundation**

According Harmse, E. 2015, before measurement of any section of a structure takes place, a check list of all the items to be measured must be provided. The list of ten items to successfully measure the foundation from bottom of trench to the underside of surface bed, are:

- Site Clarence
- Excavation of surface trench
- Risk of collapse to sides of trenches
- Risk of water
- Concrete in footings
- Masonry in footings
- Backfill to trenches
- Cart away surplus soil
- Hardcore fill under surface bed
- Extra over ordinary bricks for external facing

This is to ensure that all work and materials to be used that will cost money are covered. This important procedure must not be left to memory in the head. When confronted with this fact in the interview, S2 thought he could recall from memory the check list of items that is required to successfully measure the foundation, but his memory failed him, hence he scored the lowest mark in the task based activity.

2; **Writing of incomplete descriptions and its negative consequences (add cp11 good data analysis)**

S2 did not write complete and good descriptions of the items to be measured under foundation. When confronted with this short coming, he conceded he did not foresee that writing incomplete description could affect the builder/ contractor and the owner in a negative way.

Description of the quality of work, materials and workmanship must always be stated without any ambiguity or second guessing to protect the integrity of work to be delivered to the owner. (Lee. S . 2014).This is to ensure the owner has value for his money; eliminating any tendency for shoddy work and the use of inferior materials. It is also to ensure the safety of the workers on site, as non-adherence to any described building regulation can results in fatalities on site, e.g .ignoring the quality and strength of concrete (15 MPA) described in the specification. To achieve this objective description should be based on at least five factors;

- The recommendations of the Standard System of measuring building work in South Africa
- The specifications (of the quality of materials and workmanship)
- The working drawings' constructional details of materials
- The working drawings dimensions of work and materials
- Concise unambiguous English Language

(Brinks, C.,2015, Lee, S. 2013; Harmse, E. 2015)

Contractor suffering the penalty of defect liability'

When a contractor fails to adhere to the description of the quantity and quality of materials and workmanship, and uses inadequate an inferior material or workmanship, his work is rejected; he is ordered to remove the offending materials and replace them with the specified materials in quantity and quality, and make good his work at his own expense. This is to ensure that three important design requirement are adhered to:

(1) Limit state (the safety of the structure to carry it imposed, dead, and life loads) are not impaired.

(2) The serviceability state (which is the comfortable use of the structure, without adverse effect on health of occupants) is adhered to.

(3) The fatigue state of the structure due to unexpected environmental loading stress eg, gailforce, or tornado is taken care of during design and construction.

3; **Incorrect order of writing dimensions.**

The dimensions for excavation in earth for surface trenches not exceeding 2m deep were accurately calculated but the order of writing the dimension of length, breadth, and height was not followed which is a sign of carelessness; an altitude abhorred in quantity surveying.

4; Nil

In setting out the dimensions for cart away of surplus soil to a place to be described, the height of excavation of .20m was printed in and cancelled out. Since this is contract document, the word NIL is written against any figure that need to be cancelled. This is to avoid any fishy deal in an all-important contract document such as the bill of quantities.

5; **Risk of collapse to sides of trenches not exceeding 2m deep: poor assessing and processing of dimension information**

Risk of collapse to sides of trenches could not be calculated due to S2's inability to read and interpret the drawings to assess the required information. Two dimension were required here; the centre line value of L= 24680mm and the height of excavation of B=200+525-75-200=450, and the information recorded in columns 1, the timising and dotting column; 2. The dimension column; 3. The squaring column; and 4, the description column, as shown below.

1	2	3	4
2/	24.68 0.45	 22.21	Risk of collapse to sides of trenches n.e 2m deep L=2(4000+9000)-4/330=24680 B=200+525-75-200=450

6; **poor assessing and processing of information from engineering graphics and specification drawings:** In a similar manner the following quantities were wrongly assessed and processed. Please look at the marking guidelines/ memo as to how S2 should have measured these quantities correctly as shown below.

- Masonry in footings of one and half brick wall built in stretcher bond with cement clay
- Back fill to sides of trenches
- Cart away of surplus soil from site to a place to be described
- Extra over ordinary bricks for external facing, TWO courses below ground level

			Masonry in footings of one-and –half wall built in wall built in stretcher
	24.68		bond with cement clay
	0.45		L=24680
			B=525-75=450
	24.68		Backfilling to sides of trenches
	o.14		L=24.68
	o.25	1.73	B=(600-330)/2=135mm=0.14m (to two2 d.p)
			H=525-75-200=250

			Cart away surplus soil to a place to be described Add excavation in earth for surface trench n.e.2m deep.
	24.68 0.60 0.45	6.66	
			Ddt Backfill to sides of trenches
2/	24.68 0.14 0.25	1.73	
	26.00 0.35		Extra o.o.bricks for external facing from 2 course below ground level L=2(4000+9000)=26000 B=150+200=350

7) Recording of dimensions in meters to two decimal places

The accepted practice in setting out dimensions in the dimension column is to write the dimension to two places of decimals. In setting out the dimension of hard core fill under trenches, S2did not follow the accepted convection and wrote, Length 3.3m instead of 3.34m.,making the dimension short of 400mm, a huge unacceptable mistake in a quantity surveying document, the height of 0.20m as written as 0.2m,which does not show the required two decimal places.

7; S2 also did nothing at all to process the information on ABSTRACTING and BILLING sheets,

The candidate inability to process the measured data on the abstract sheet means he will not be able to produce the bill of quantities as a contract document that could be used as basis for pricing, tendering, preparation of monthly interim valuation for paying contractor and his staff nor the final account to contractor when he finish his job.

The candidate's understanding of assessing and processing of information from engineering graphics and specification drawings to produce the bill of quantity as a contract document is deficient and requires strong motivation by all stakeholders to put him on track.

8, Analysis of Constructional Details (refer to question two and memo of the task based activity)

8; The participating candidate also did not answer question two; where he was required to sketch to a reasonable scale to show the constructional details of a solid casement (timber) window with sashes and fanlight opening outward built into the centre of one-brick wall plastered only on the inside. Indeed none of the eight participating candidate answered this question satisfactorily.

The conclusion here is that the use of the imaginary cutting plane to elucidate the constructional details of hidden materials, the hatching techniques and material symbols to show the various types of materials to be used in building construction require effort of teachers for learners to overcome the challenge. One solution will be for teachers to encourage learners to go on regular site visits to see artisans at work during the construction phases of projects. This will ensure that constructional analysis by sketching stipulated section of a building structure in the curriculum is effectively grasped by learners.

The required sketch expected of the participant is reproduced here; scanned copy

My reflections

The interviews that I conducted with N4 QS students had a profound effect on me, rather than reflecting on their engagement with engineering specification drawings I began introspecting on myself, my teaching and who the student I lecture to are. I declare upfront that I deviated from my data generation plan.

I really don't know the N4 QS students that I lecture even though I have a small class. Who are they? How can they not pass? What do they do at home? Do they even bother to study? Do they consider the effort I put into my teaching? Why are they absent so frequently? Why do they not seek clarity if they don't understand? What can be done to improve their low literacy and numeracy levels? These are a few of the questions that confronted me during Phase 2 of data generation. Am I unable to answer these questions because I don't care or is it because I am always trying to cram as much content as possible in a short space of time (two months)? What can I do to alter the prevailing situation?

Should I get the student to keep a learning diary so they can review their own learning process, the concepts they learnt, the ones they don't grasp as well as their transition to DCC and its environment? I think these students maybe experiencing anxiety related to transition -when they moved from school to DCC and when they move between their "home world" and the world of DCC. They are still adjusting to DCC and there seems to be a lack of connectedness to ease their move between worlds that are very different. I was unaware of their roles in their home world. I think getting students to keep a learning diary will help them with the process of setting goals and having an agenda to learn. Via this research project I am also learning, previously I never reflected on students' engagement or my teaching. I have come to realise that student engagement also involves an emotional and cognitive aspect as well. The emotional aspect relates to students' reactions to teachers, the school context, their connectedness with the school and peers. The cognitive aspect refers to students' level of effort, their study habits, willing to try new learning strategies.

I thought that when I spoke softly I was showing respect to the student and that I was not shouting at them. I didn't think that the audibility of my voice impacted their learning and engagement with content matter. I should also try and create a more collaborative learning environment in my class

and adopt teaching approach's that suit my student's needs. I should encourage them to ask questions and I should also ask them questions while I teach. In retrospect I realise that I rely heavily on teacher centered methods of teaching without much room for student engagement. Further I'm more concerned with syllabus coverage and maximizing the delivery of information (such as rules, definitions, procedures for students to memorise) rather than student learning as a result I pay little attention to students' needs or misconceptions

My Reflection on collages made by learners

As already explained, collages are pictures pasted on a flat surface to tell a story.

Learners were given many pictures from which they were to select suitable pictures to express their feelings, difficulties, struggles and what motivates them and keep them pushing on with their studies

Learners made interesting collages that express their difficulties but which also gave them hope for a better future.

Picture number one depicts a learner with pile of books on which a clock sits. This picture clearly showed learners have very little time to accomplish the expected success they aspire to achieve at the end of their course. A similar picture with a student looking into his book with a clock near by him tells the same story of the availability of little time for students to go through their course.

Further, household chores learners are obliged to perform take much of the time allotted for their studied

The N4 curriculum is designed as 3 months course for learners studying for the National Diploma in Engineering and other NATED courses. Many of the learners enrolled for the National Diploma course in Engineering have no technical background, a consideration the planners of the curriculum glossed over and did take into consideration. Similarly, the minimum recognised failed pass rate of 30% in the gateway subjects of Mathematics and Physical Science required for admission to the National Diploma course show that learners studying the Engineering Courses have very limited content background to successfully per sue the course.

For learners to be successful therefore, educators provide bridging courses to assist learners to overcome the challenge. This bridging course takes almost 3 months to complete. It therefore, require flexibility on the part of educational institutions and all stakeholders to make adjustment such that 6 months of study is allotted for slow learners and those without technical background and Mathematics and Science deficiencies to be able to successfully complete Engineering course at each of level of N4, N5 and N6.

My class register show high learners absenteeism .My investigation reveals some students are baby sitters, other are DJs and takes off time to perform to raise funds to pay school fees, still other travel long distances using train to commute; arriving late at college and leaving college early to catch train back home. While these personal struggles of learners outlined above may hamper learners' progress at college, they are not excuse for failure. The researcher suffered the same fate while at college but rose above the circumstances to be successful in his college studies.

One could see that learners indeed do struggle to cope with their studies .These struggles that learners go through were expressed in the collages they made. Pictures of learners pushing/rolling heavy loads were displayed. Others show mountains to be climbed. Other pictures show ladder reaching the skies which learners are expected to climb step by step.

In all these learners are not discouraged; because they rely on the supports provided by their peers, family and teachers in their studies.

Learners have different learning styles as already ex dies.

Students displayed pictures where the see a new dawn in their personal struggles as a result of a final breakthrough in their struggles that allowed them to see light at the end of a tunnel.

Having reflected on phase 3 of data generation, especially observing students engaging in collage making and concept mapping I realise that the factors that impede N4 QS students' engagement with engineering graphics specification drawings are: student background, perception of learning environment, teaching style, study habits, carelessness, inability to read diagrams, lack of skills to perform simple calculations, lack of awareness of the standard system, students inability to juggle family responsibilities with study responsibilities, anxieties, confusion, being overwhelmed by large volumes of content information (*jargons*). The factors that can promote N4 QS students'

engagement with the assessing and processing information from engineering and graphics and specification drawings are equipping students with the skills needed to cope with the module content, breaking the content into smaller bits that is more comprehensible, changing my teaching methods, having more hands on activities, having a positive expectation of students as well as getting to know them.

Engaging in this research project has made me realise that teaching goes beyond the delivery of content to comply with syllabus requirement. That there are specific teaching "behaviour" which when implemented appropriately in my classroom will impact student engagement and thereby improve students' academic achievement. Teaching goes beyond the technical aspects of maintaining a register, recording marks and completing the syllabus. A large part entails having you heart in it as well, it has a moral and ethical dimension as well. I have an obligation to my students. I now am thinking about how to use the knowledge I acquired about factors that impede and promote N4 QS N4 QS students' engagement with the assessing and processing information from engineering and graphics and specification drawings in the planning of my teaching (both in terms of the subject matter content and the teaching strategy that I use). How I portray important content specific information to students is now important to me. I must be able to convey these complex ideas in a simpler way that is accessible to students. I must be more sensitive to the challenges students encounter during their engagement in order to improve my teaching.

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